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K/TSO-017
Rev. 3

UF_6 CYLINDER PROJECT

SYSTEMS ENGINEERING MANAGEMENT PLAN

JULY 1998

ENRICHMENT FACILITIES MANAGEMENT

K/TSO-017
Rev. 3

UF_6 CYLINDER PROJECT

SYSTEMS ENGINEERING MANAGEMENT PLAN

ENRICHMENT FACILITIES MANAGEMENT

JULY 1998

Prepared by:
BECHTEL JACOBS COMPANY LLC
for the
U. S. Department of Energy
under contract
No. DE-AC05-98OR22700

K/TSO-17, Rev. 3
UF_6 Cylinder Project
Systems Engineering Management Plan

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Change Page Notification for
UF_6 Cylinder Project
Systems Engineering Management Plan
K/TSO-017, Rev. 3

Page	Paragraph	Change	Reason
18	3.1.2	Added reference to Bechtel Jacobs Company LLC Integrated Safety Management System (ISMS)	Provide updated safety program approach and references.
A-2, A-3	Appendix A	Replaced DOE 5480.24 with ANSI 8.1, 8.3, 8.7, 8.19, and 8.20 as applicable.	Maintain consistency with Work Smart Standards and Bechtel Jacobs Company LLC contract, and the Project SRD.
B-2	Appendix B	Add reference to the requirements analysis for cylinder yard fire controls.	Incorporate recent detailed decision analyses within the Project

The above table identifies the substantive changes in the Systems Engineering Management Plan from Rev. 2 to Rev. 3. Bechtel Jacobs Company LLC, requests your approval of these changes.

Approval is accepted when following signatures are present:

Signature of the Requesting Organization:

7/27/98

M. S. Taylor, Three-site Project Manager

Signature of the Concurring Organization:

7/27/98

J. W. Parks, DOE-ORO Assistant Manager for Enrichment Facilities

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LIST OF ACRONYMS

ASME	American Society of Mechanical Engineers
BIO	Basis of Interim Operation
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DUF_6	depleted uranium hexafluoride
EDP	Engineering Development Plan
ISMS	Integrated Safety Management System
NMC&A	Nuclear Materials Control and Accountability
PE	Project Execution
PGDP	Paducah Gaseous Diffusion Plant
PHA	Preliminary Hazard Assessment
PI	Project Integration
PMP	Project Management Plan
PORTS	Portsmouth Gaseous Diffusion Plant
SEMP	Systems Engineering Management Plan
SRD	System Requirements Document
UCLIM	UF_6 Cylinder Location, Inspection, and Maintenance
UF_6	uranium hexafluoride
WBS	work breakdown structure
WCS	work control structure

EXECUTIVE SUMMARY

The Department of Energy manages an inventory of uranium hexafluoride through the Uranium Hexafluoride Cylinder Project. The Project addresses a finite inventory of uranium hexafluoride. This Project's mission is to safely store the DOE-owned UF_6 inventory until ultimate disposition of the material. The bulk of the inventory is 560,000 metric tons of depleted uranium hexafluoride. The inventory is stored as a crystalline solid under vacuum, principally in steel cylinders with capacities of 10 or 14 tons. The cylinders are maintained at three sites: Paducah, Kentucky; Portsmouth, Ohio; and Oak Ridge, Tennessee. In storage, cylinders are stacked two high in double rows, outdoors on concrete and gravel. The cylinders are managed under Department of Energy Orders and Directives derived from the Atomic Energy Act and under other relevant legislation and regulations.

This Systems Engineering Management Plan defines the Systems Engineering approach outlined in the Department of Energy Implementation Plan responding to Defense Nuclear Facilities Safety Board Recommendation 95-1 and specifies the methods for planning and controlling the activities within the Project. These methods are used to integrate today's activities of the system managing the uranium hexafluoride inventory. The Systems Engineering Management Plan includes the specific activities necessary to define, upgrade, and maintain a system configuration.

Key Systems Engineering techniques used to integrate Project activities include: identifying requirements; establishing traceability of requirements from the Project mission to implementing documentation; verifying activity development and completion; and improving the system configuration by identifying and controlling interfaces between system functions (e.g., the interface of periodic cylinder inspections with maintenance and containment integrity forecasting). Verification techniques are instituted within the system to ensure that development activities contribute to improving the system configuration and that field implementation of activities meets the requirements.

The planning and control methods defined in the Systems Engineering Management Plan include risk management, a work control structure interface control, performance measurement, and configuration management. The concept of developing, implementing, and adhering to a baseline is controlled through configuration management.

Activities essential to complying with requirements are documented. These activities were identified through the requirements analysis process performed by about thirty subject matter experts in the fields of uranium hexafluoride cylinder operations; Environmental, Safety, and Health; Systems Engineering; and Project management. It is anticipated that these activities will be improved through subsequent iterations of the requirements analysis process per the Systems Engineering approach. Activities derived from the requirements analysis demonstrate progress in applying Systems Engineering to the UF_6 Cylinder Project.

Activities derived from the requirements analysis either necessitate development or are ready for implementation. Activities for development (development activities) are managed through the Engineering Development Plan, and activities that are ready for implementation (implementation activities) are managed through the Project Management Plan. A notation is made as to whether each activity is to be managed through the Engineering Development Plan or the Project Management Plan. The Systems Engineering Management Plan also provides guidance for the sequencing and scheduling of development and implementation activities.

The Systems Engineering Management Plan is used by Project personnel as a reference for identifying required activities, demonstrating traceability of activities to requirements and vice versa, bounding as a minimum the planning and control tools to be exercised, and specifying the systematic approach to making defensible decisions.

1. INTRODUCTION

1.1 BACKGROUND

The Department of Energy (DOE) owns an inventory of uranium hexafluoride (UF_6) nominally less than 5% enrichment. This inventory is managed by the UF_6 Cylinder Project. The bulk of the DOE inventory is 560,000 metric tons of depleted UF_6 (DUF_6) produced by the gaseous diffusion plant enrichment process while the plants were operated by DOE and its predecessors. The balance of the inventory is normal assay and low-enriched assay UF_6 contained in cylinders.

The inventory is stored as a crystalline solid principally under vacuum. The DUF_6 is stored primarily in 48-inch-diameter steel cylinders with capacities of 10 or 14 tons. Typical cylinders are 5/16-inch-thick pressure vessels that were designed and manufactured to the American Society of Mechanical Engineers (ASME) code.[1] The cylinders are maintained at three sites: the Paducah Gaseous Diffusion Plant (PGDP), in Paducah, Kentucky; the Portsmouth Gaseous Diffusion Plant (PORTS), in Piketon, Ohio; and the East Tennessee Technology Park (formerly known as the K-25 Site), in Oak Ridge, Tennessee. The inventory of cylinders containing DUF_6 is distributed at the three sites as follows: 28,400 cylinders at PGDP; 13,400 cylinders at PORTS; and 4,700 cylinders at the East Tennessee Technology Park.

After significant inventory of DUF_6 was produced from the enrichment process, outdoor storage facilities evolved independently at the sites. Cylinder yards were constructed of either concrete or compacted gravel, and cylinders were stacked in two-tiered row on wooden or concrete saddles. The handling equipment used to stack these cylinders in double-tiered rows has also evolved, from mobile cranes to specially designed tractors that grasp and lift the cylinders with hydraulically actuated tines.

Until 1990, surveillance of the DUF_6 consisted of an annual nuclear materials inventory of the cylinders. The East Tennessee Technology Park cylinder yards were surveyed in May 1990 to provide input for planning long-term corrosion monitoring of cylinders. Cylinder valves with corrosion and evidence of potential valve leakage were discovered. A June 1990 survey of valves of cylinders at PORTS revealed two cylinders with breached side walls. Investigation of these cylinder breaches determined that the causes were mechanical tears caused by impact from the lifting lugs of adjacent cylinders.[2] Subsequent inspections of stored DUF_6 cylinders revealed four breached cylinders at the East Tennessee Technology Park. Two breaches were attributed to handling damage, and two were most likely initiated by external corrosion resulting from substandard storage conditions.[3] Another breached cylinder resulting from handling damage was discovered at PGDP.

The risk to personnel health and safety, and the potential environmental impact, posed by these cylinder breaches and valve leaks has been low, by nature of the system. The UF_6 inventory is stored as a solid. Reaction deposits formed when UF_6 is exposed to the atmosphere in the presence of the mild steel containers have a self-sealing nature. The bulk of the inventory is depleted in the fissionable isotope of the UF_6 such that the hazard is mostly chemotoxic, not radiological. These factors contribute to the low risk incurred from these and potential additional failures. This low risk was confirmed by analysis of the air and soil samples collected near the breaches at PORTS and by subsequent weighing of the cylinders. Although the risk posed by these breaches is low, the existence of breached cylinders heightened the importance of a comprehensive, long-term three-site cylinder management program. Consequently, in 1992, a cylinder integrity management plan was developed to address concerns within the storage yards and to establish the initial premise of the Project today.[4]

On May 5, 1995, the Defense Nuclear Facilities Safety Board (DNFSB) issued to DOE Recommendation 95-1,[5] regarding the storage of depleted UF_6 in cylinders. The recommendations are summarized as follows:

- Start an early program to renew the protective coating of cylinders containing the tails from the historical production of enriched uranium.
- Explore the possibility of additional measures to protect these cylinders from the damaging effects of exposure to the elements, as well as any additional handling that may be called for.
- Institute a study to determine whether a more suitable chemical form should be selected for long-term storage of the depleted uranium.

On June 29, 1995, DOE accepted Recommendation 95-1[5] and emphasized five focus areas for DOE response:

- removing cylinders from ground contact and keeping cylinders from further ground contact;
- relocating all cylinders into adequate inspection configuration;
- repainting cylinders as needed to avoid excessive corrosion;
- updating handling and inspection procedures and site-specific Safety Analysis Reports; and
- completing an ongoing study that will include an analysis of alternative chemical forms for the material.

On October 16, 1995, DOE submitted an Implementation Plan[6] that incorporated completed and near-term activities in accordance with these five focus areas. The Implementation Plan[6] also committed to managing the UF_6 Cylinder Project using a Systems Engineering approach. The approach was developed concurrent with field response activities and was enhanced through an open dialogue among DNFSB staff and personnel from DOE and Lockheed Martin Energy Systems, Inc. The Implementation Plan[6] specifies the following interim and final deliverables and defines their respective content to establish an operative Systems Engineering process for the continued improvement of depleted UF_6 management through the UF_6 Cylinder Project. The deliverables are:

- System Requirements Document (SRD);[7]
- System Engineering Management Plan (SEMP);
- Engineering Development Plan (EDP);[8]
- UF_6 Cylinder Project Management Plan (PMP);[9] and
- Approved Safety Analysis Reports.[10, 11, 12]

1.2 SYSTEM OVERVIEW

The ***mission*** of the UF_6 Cylinder Project is to safely store the DOE-owned UF_6 inventory until its ultimate disposition. The ***system*** established to meet the Project mission is the means by which containment is achieved. The system comprises ***components*** (such as the UF_6 cylinders, cylinder yards, cylinder-handling equipment, personnel, and financial resources) and ***activities*** (such as operations, management processes, and administration).

The existing cylinders used to contain the UF_6 inventory are typically constructed with 5/16-inch-thick, mild steel walls and have a capacity of 10 or 14 tons. A bounding assumption identified in the SRD is that the system can and will continue to use the existing cylinders. Because of this assumption, the current phase of the system emphasizes maintaining the containment integrity of the existing cylinders. The containment integrity of the cylinders must be maintained to progress the system from the current storage phase to the subsequent dispositioning phase.

The system includes several ***operational functions*** to maintain the containment integrity of the cylinders. These operational functions are:

- Surveillance and Maintenance,
- Handling and Stacking,
- Contents Transfer, and
- Off-site Transport.

These functions are made up of components (physical equipment, personnel, documentation, etc.) and activities. The flow of the operational functions is illustrated in Fig. 1.1.

In addition to the operational functions, the system requires ***development and administrative support functions,*** such as engineering development to realign and sustain the system effectiveness in accomplishing the Project mission.

Major objectives for the Project, as derived from the situation analysis documented in the SRD, provide the emphasis areas for the Project. These major objectives have been used to facilitate identification of system and technical requirements. The major objectives are:

- Achieve and maintain acceptable risks,
- Achieve and maintain cylinder integrity,
- Improve conduct of operations,
- Evaluate and monitor containment integrity, and
- Administer the system.

These objectives segment the safe storage mission of the Project in response to the current condition of the system and the projected life cycle schedule for completing the last phase of the system (Decontamination & Decommissioning). These major objectives reflect the necessary focus areas to progress the system from the current phase to the subsequent phases.

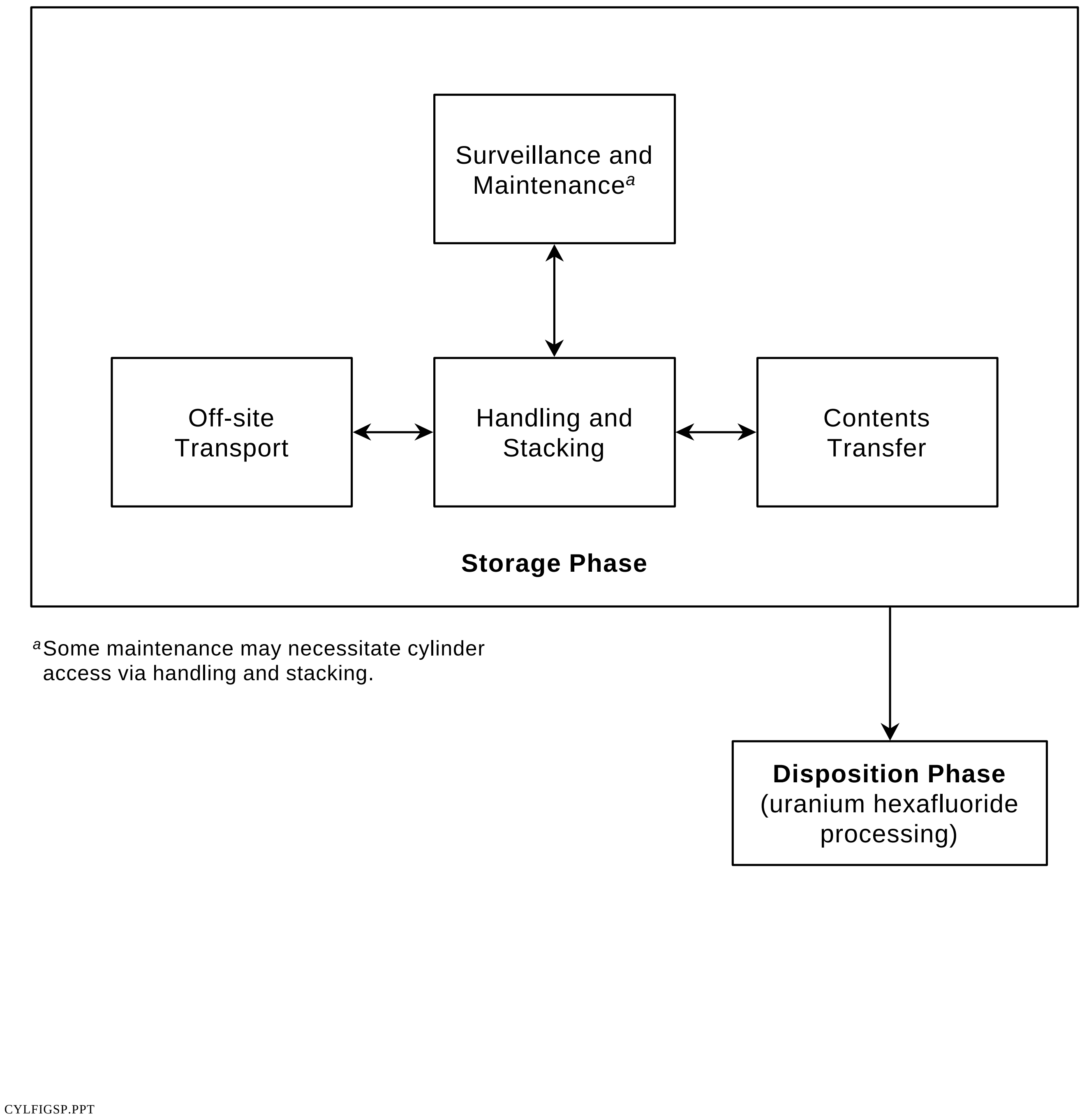


Fig.1.1. Functional relationship of operations.

1.3 PURPOSE OF THE SEMP

The SEMP documents the Systems Engineering process and the tools used by Project personnel to make decisions while planning and controlling work activities. The process and tools provide assurance that the storage system used to execute the Project is integrated and accomplishes the Project mission. Project personnel use the SEMP as a reference to ensure that the Systems Engineering process and tools are used to the extent prescribed herein. Also, the SEMP is provided to DOE as assurance that the contractor has established sufficient rigor in the Project to accomplish this mission. For this reason the SEMP is a joint DOE and prime contractor approved document under the same change control mechanism as the SRD.

1.4 ORGANIZATION OF THE SEMP

This SEMP adopts the standard SEMP format identified in the Defense Systems Management College Systems Engineering Management Guide[13] and is reflective of most Systems Engineering efforts. This SEMP has five sections:

- ***Systems Engineering Approach***—Section 2 describes the Systems Engineering approach taken by the Project. The approach is determined based on the complexity of the system and necessary rigor for achieving a satisfactory level of integration of activities within the system. The approach is also based on the understanding that there is an existing UF_6 cylinder system in place and the task is realignment and integration of the existing system.
- ***Planning and Control***—Section 3 describes the organization, planning, and control mechanisms to be used within the Project to manage the system for compliance with requirements and subsequent baselines including cost, performance, and schedule goals. This section establishes the tools and system processes for developing and adhering to the baseline configuration established by the Systems Engineering effort. The detail and rigor associated with these tools and processes are also reflective of the complexity of the system and are intended to correct the inherent deficiencies within the current system configuration.
- ***Specialty Engineering***—Section 4 describes the specialty engineering disciplines to be used in the Systems Engineering process. Typical SEMP specialty engineering sections discuss the integration of engineering disciplines that may not drive the development of a particular hardware or software item but are necessary in order that the end product meets interactive requirements. Specialty engineering disciplines typically include areas such as reliability, maintainability, human factors, environmental issues, and health and safety. The system tasks for this mission do not emphasize the development of hardware or software items but rather the improvements to the existing system components and activities. Section 4 of this SEMP reflects the appropriate application of specialty engineering to UF_6 cylinder management.
- ***Requirements Analysis***—Section 5 provides a description of the initial requirements analysis approach and establishes the major objective and requirement category hierarchy.
- ***Next Steps***—Section 6 focuses on providing guidance to Project management in planning and executing needed actions identified from the Requirements Analysis.

2. SYSTEMS ENGINEERING APPROACH

The Systems Engineering approach for managing the UF_6 Cylinder Project is outlined in the DOE Implementation Plan[6] and is further explained in four primary documents:

- SRD—identifies the system requirements;
- SEMP (this document)—defines the overall Systems Engineering process, specifies the management tools to be used by the project, and documents the results of requirements analysis;
- EDP—identifies development activities, costs, and schedules for technical improvements; and
- PMP—identifies costs, schedules, and activities for executing the project as a whole.

The Systems Engineering approach described in this section has six basic interrelating steps:

- Mission Development
- Functional Analysis
- Requirements Analysis
- Required Development
- Implementation, and
- Change Control and Improvements

The approach is depicted in Fig. 2.1. As shown, this process is continuous, and requirements analysis is the central point. The requirements analysis is the decision-making point to determine whether identified activities sufficiently satisfy the requirements and objectives of the system or whether the activities should be developed to enhance how the system complies with requirements and objectives. The continuous process shown in Fig. 2.1 also expresses the iterative nature of Systems Engineering. When an analysis is performed with a given level of input, the analysis may provide information to improving the input in detail or in scope. Successive iterations through the process result in greater understanding of the system and provide opportunities to improve previous information. Successive iterations are controlled by the need for further understanding of the system parameters and the degree necessary to ensure that the Project accomplishes its mission.

A further description of the steps within Systems Engineering approach is provided in the following subsections.

2.1 MISSION DEVELOPMENT

The Project mission and the process by which it was established are documented in the SRD. The process was initiated by identifying the scope of the Project and the inherent expectations associated with the scope. The mission was jointly developed by the prime contractor and DOE. As specified in the SRD, the scope of the Project includes UF_6 assets not transferred to USEC in accordance with the Hall Amendment of 1993.[14] The scope of the Project comprises primarily DUF_6

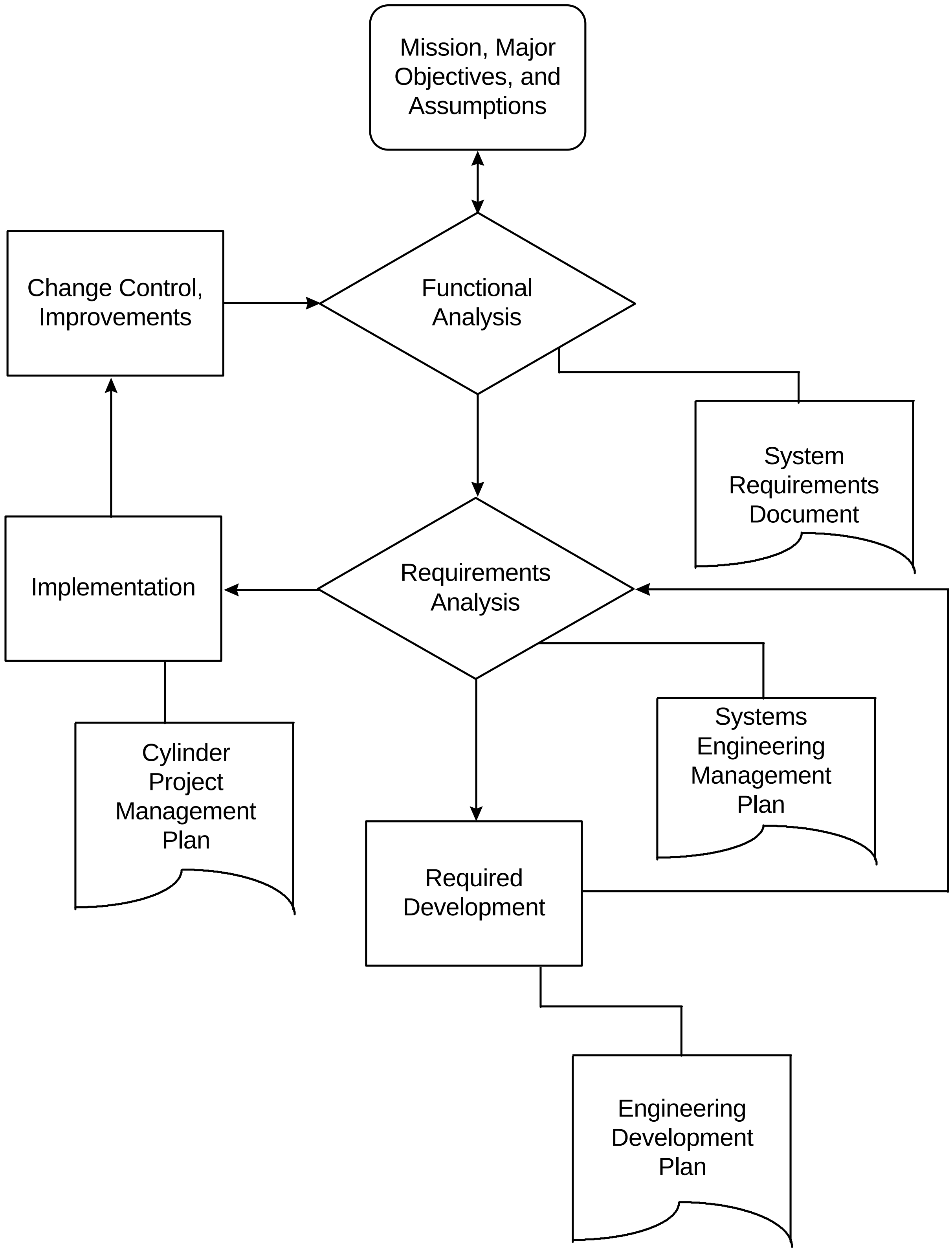


Fig. 2.1. Systems Engineering approach.

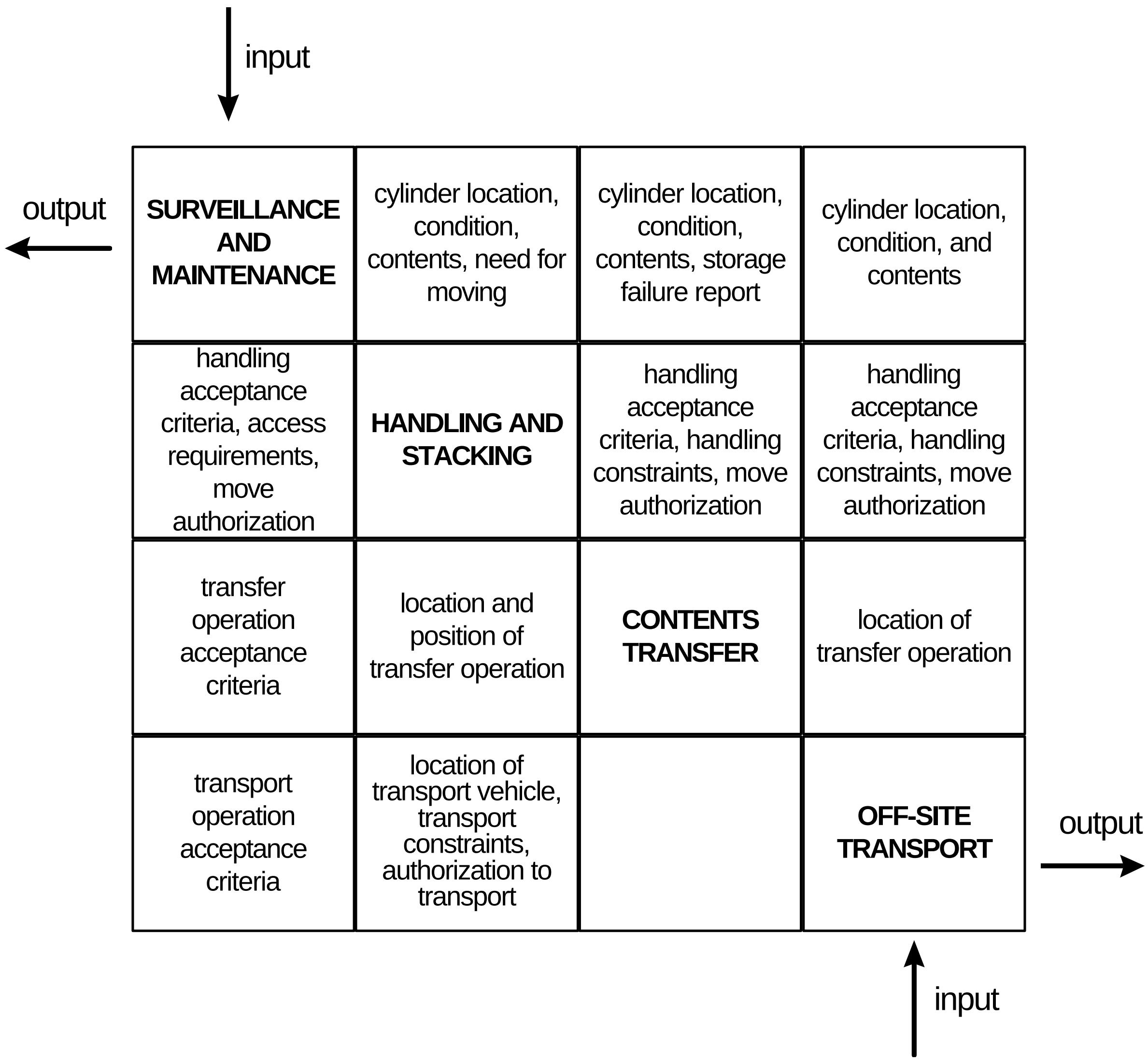
currently in long-term storage. Thus, the Project mission is to safely store the inventory until its ultimate disposition. The timing of ultimate disposition has been provided by DOE and is currently being reviewed for possible revision. DOE is developing the ultimate disposition strategy and evaluating the beneficial uses of UF_6 via a Programmatic Environmental Impact Statement. The timing of the disposition activities will be determined by DOE based on beneficial uses, market driven demands, and available resources.

To ensure that the Project accomplishes its mission, major objectives that fulfill the mission were identified. The process for identifying the major objectives included an analysis of the current condition of the system components and activities, and the needed functionality of these system components and activities at the time of disposition. The situation analysis included a review of the DNFSB/TECH-4[15] report and a review of the available data to characterize the physical condition of the inventory. To address the conditions of the system components and activities that are not fully defined (e. g., present condition of the inventory, requirements for ultimate disposition), assumptions used during the situation analysis were documented. These assumptions are monitored and where feasible (within the scope of the Project) activities are taken to transition the assumptions to known facts or conditions where the assumptions are not necessary to bound and operate the system. The situation analysis concluded with the identification of a root cause and contributing causes to systemic problems within the scope of the Project. Major objectives of the Project are oriented toward overcoming these problems and effectively sustaining a safe storage system.

2.2 FUNCTIONAL ANALYSIS

After the prime contractor and DOE agree upon the mission statement, major objectives, and bounding assumptions, a functional analysis of the system is performed. The functional analysis identifies the primary functions within the bounds of the system and the components and activities within these functions. This information is incorporated in the SRD. The functional analysis can be an iterative process in itself, with successive iterations dividing the system functions into greater detail. The need to perform successive iterations is driven by the need to describe and control the system sufficient for mission accomplishment. Tools available to complete a functional analysis include functional flow block diagrams and N2 charts. Functional flow block diagrams break down a function into subfunctions illustrating the logical progression of the subfunctions. The block diagram for the four system operational functions is shown in Fig. 1.1. N2 charts identify the relationship between functions listing inputs and outputs of these functions as they relate to other functions. The N2 chart for the four operational functions is shown in Fig. 2.2.

The product of a functional analysis is a system definition that is sufficient to allow identification of essential characteristics (requirements) that are necessary to meet the major objectives and mission of the Project. These requirements can be essential characteristics of an activity within the system or essential characteristics of a component or product the system uses or produces. Whenever feasible these requirements are expressed in measurable terms, to facilitate verifying compliance. If a requirement is not expressed in measurable terms, compliance with that requirement is subjective.



CYLFIGSP.PPT

Fig. 2.2. N2 Diagram, functional flow of operations.

Requirements allocated to the system are approved by DOE. This approval is an acknowledgment that the system must achieve and maintain compliance with these requirements to fulfill the Project mission. The baseline of requirements is documented and maintained in the SRD.

Compliance with requirements necessitates a sufficient allocation of resources. If sufficient resources are not available, it may be necessary to revise the requirements or mission or to obtain an exemption from the requirements from DOE. It may also be possible to obtain a temporary exemption from the requirement, and while the exemption is in effect, initiate development activities to find alternative methods for meeting these requirements.

Requirements are expressed as ***system requirements*** or more detailed ***technical requirements***. The system requirements represent a comprehensive list of essential characteristics necessary to successfully meet the Project mission and major objectives. Technical requirements are subordinate to system requirements and provide the specificity necessary for safe operation of the system.

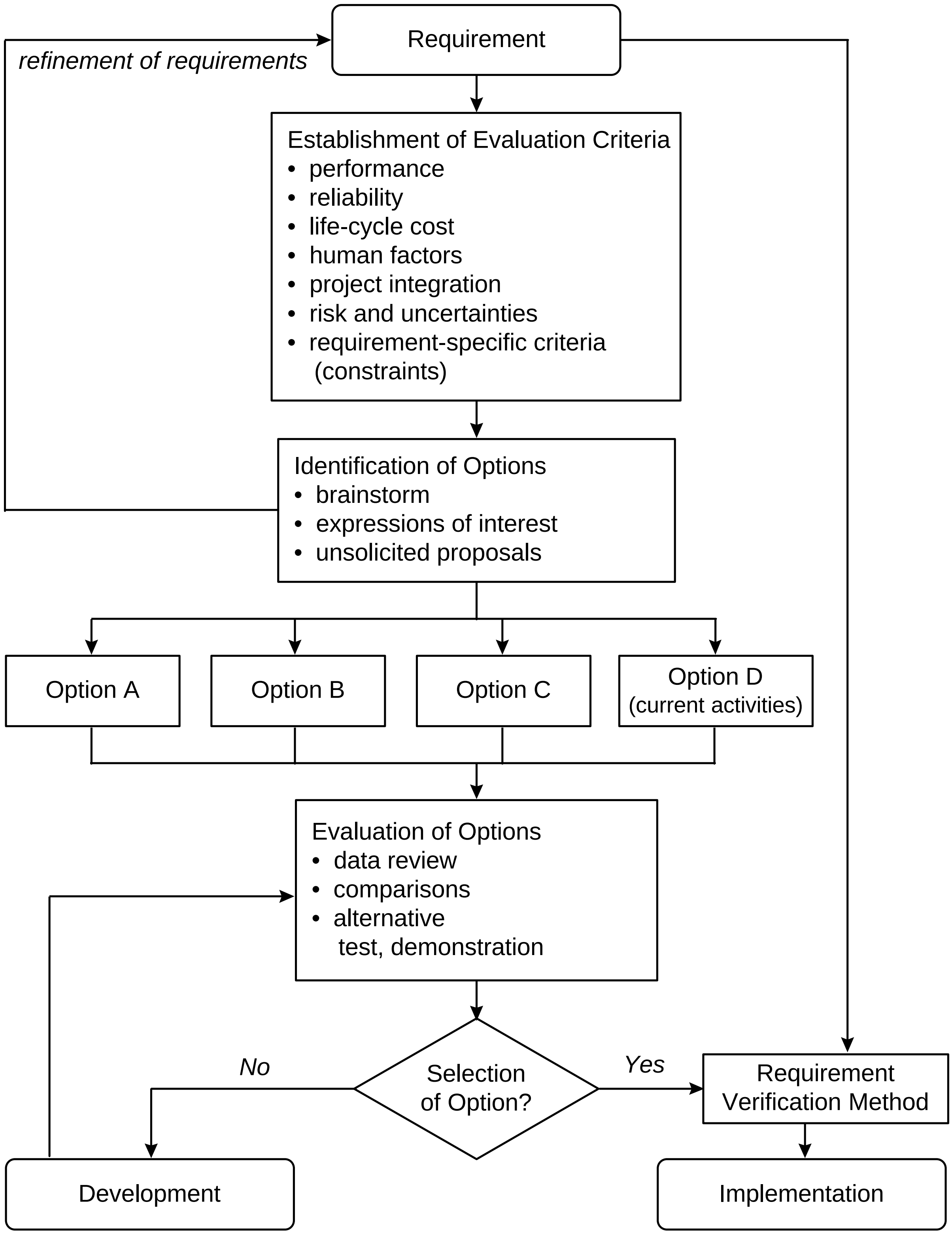
Requirements, where applicable, are linked to existing standards adopted by or imposed on the project. This link provides reference to DOE Directives and Orders, external regulations, and governing organizations. This link also provides the project with nationally proven methods and specifications for components and activities within the system. If necessary standards are non-existent, internal standards will be developed. If nationally accepted standards applicable to system components and activities are not readily adapted, the project will pursue exemptions (or constrained exceptions) to those standards.

2.3 REQUIREMENTS ANALYSIS

After the system functions and essential characteristics (requirements) are identified, an analysis is performed to determine how these requirements are to be met. This analysis constitutes a successive iteration on the overall Systems Engineering approach. The general process for identifying acceptable methods for meeting requirements is shown in Fig. 2.3. A graded approach is used in applying this process. Prior to initiating the requirements analysis process, the applicable components and activities are reviewed. This review is facilitated by the documented functional analysis. Key blocks are shown in Fig. 2.3 and are described in the following paragraphs.

Establishment of Evaluation Criteria**—**Once the applicability of the requirement is understood, evaluation criteria are established to ensure that selected options will meet the requirement. These evaluation criteria are established by listing the characteristics of activities necessary to meet a requirement and then selecting the preferred activity. Typical evaluation criteria are shown in Fig. 2.3.

Identification of Options**—**The next step in the requirements analysis process is the identification of optional methods to meet the requirement. This step can be accomplished by brainstorming, listing current methods and methods proposed by other organizations.



CYLFIGSP.PPT

Fig. 2.3. Requirement analysis process.

Evaluation of Options—Each option is assessed against the evaluation criteria and compared with other options. To complete the evaluation of options it may be necessary to explore or develop an option or to assign a low grade to less developed options, because of uncertainties. Further development is described in the Required Development section of the SEMP.

Selection of Option—After review of the options in comparison to one another and the evaluation criteria, a preferred option is selected. When an option is selected for implementation, a verification method is documented to demonstrate that the requirement is met. Implementation is accomplished through integration with the existing Project. This implementation task is managed by the PMP. If an option is not selected for implementation, activities are initiated to further develop one or more alternative concepts. Development of alternatives is managed by the EDP.

The process described above is iterative for the purpose of developing a comprehensive set of activities to meet each requirement. This iterative process also provides the opportunity to revise the requirement as necessary if 1) there are no feasible activities to meet the requirement, or 2) the requirement scope is not properly focused on the Project objectives.

Because the system is currently in operation and most of the functions are capable of fulfilling the requirements, the requirements analysis process uses the following approach:

- When adequate, current methods for meeting these requirements can be accepted.
- When no current method is available or acceptable, methods for meeting requirements are identified.

The baseline of requirements analyses is maintained by the prime contractor in the SEMP and subordinate documents. These analyses provide the rationale for decisions made by project management. Activities identified from the requirements analyses are allocated for implementation or for further development. This allocation is based on the system as whole and establishes the rationale for decision-making during the planning and budgeting activities when available funding is less than what is needed.

2.4 DEVELOPMENT

The purpose of development is to enable the Project to improve the system's effectiveness and efficiency with respect to meeting requirements. Development may be necessary to find and explore alternative solutions to meeting requirements or to create the capability for meeting requirements. Because there is already an existing system, development also may be necessary to recreate the technical basis or rationale for current activities and components if this information is necessary and is not available. This latter need for development stems from the lack of documentation on the existing system. For example, if compliance with the designated safety envelope is in question and the Project lacks the documentation to rigorously evaluate and demonstrate that risks are acceptable, it may be necessary to recreate the technical basis.

The product of development is an improved understanding of the condition of the system and an improved understanding of the present activities or alternative activities for meeting requirements. Development documentation provides the supportive information to decisions made in the requirements analysis process and thus is maintained by the Project. Decisions on the SEMP baseline of activities to meet requirements will be made by reviewing the products of development in a requirements analysis. Where appropriate this analysis may be part of the development process. Needed development activities are identified in the EDP, which also documents the development process. Needed development is organized via the Work Breakdown Structure (WBS) and controlled using the Work Control Structure (WCS).

2.4.1 Determination of the Need for Alternatives

Because a system already exists and is functional, there must first be a determination of the need for alternatives. This need is determined by characterizing the present condition of the existing system. Technical evaluations of components to baseline the present condition are managed through the EDP. Examples of technical evaluations to be managed as development activities include the characterization of current cylinder conditions, the characterization of current storage yard conditions, and modeling to forecast cylinder and yard conditions. These technical activities improve knowledge about the system and enable the Project to improve the effectiveness and efficiency with which the system meets requirements.

2.4.2 Identification of Alternatives

When it is determined that a current method or solution for meeting a requirement(s) is unacceptable or non-existent, alternatives are sought. The identification of alternatives is driven by the characteristics of the requirement(s) not being met. During the development and documentation of alternatives, features of each alternative shall be matched to established requirements. The process for identifying alternatives is described in the method for identifying options in the requirements analysis process.

2.4.3 Analysis of Alternatives

The analysis of alternatives results in a better understanding of the options so that an option can be selected. The basic approach to analysis of alternatives is to establish test or demonstration plans to verify that an alternative can meet a requirement. These development plans are then authorized and executed through the EDP. The results of these alternative analyses will be documented as supportive information to the decisions made in the requirement analysis.

2.5 IMPLEMENTATION

Implementation signifies how the system progresses toward meeting requirements and maintains that status to achieve the objectives and mission of the Project. Implementation is accomplished by planning and executing the baseline of required activities via the management tools documented in Sect. 3. Required activities are organized into executable work, work is prioritized, expectations are established, and work is authorized for completion. These implementation responsibilities are documented in the PMP. Also documented in the PMP is the WCS, which describes how the work is organized, how it will be accomplished, and to what expectations it will be completed.

2.6 CHANGE CONTROL AND IMPROVEMENTS

To complete the Systems Engineering approach and verify implementation progresses toward meeting requirements and maintaining that status, a change control process is instituted. This process involves having pre-established baselines for the Project and verifying adherence to those baselines.

2.6.1 Baselines

The Project baselines are recognized agreements between DOE and the prime contractor and have unique change control mechanisms as their emphasis areas are unique. These change control mechanisms are discussed in Sect. 3.5. The Project baseline is organized into three areas, as follows:

- The work progression baseline is documented in the Uranium Programs Baseline Plan. To aid the prime contractor in executing this baseline it is further detailed in the PMP and EDP. The work progression baseline links mission and objectives of the Project to authorized work including budget authorizations and work deliverables. This baseline is focused on fiscal year activities.
- The mission requirements baseline is a baseline for the life of the Project. This baseline is documented in the SRD and constitutes the system characteristics that must be present or achieved to accomplish the objectives of the Project. In addition to the SRD, the SEMP is a recognized agreement between DOE and the prime contractor. The SEMP provides the basis for how the Project is managed to assure mission requirements are met.
- The safety management baseline is documented in safety analysis reports and acceptance correspondence. This baseline ensures authorized work will not exceed acceptable health and safety risks. The safety management baseline is established and maintained for the life of the system.

These three baselines are interrelated and dependent upon each other. They describe DOE's overall expectations of the prime contractor. The prime contractor is responsible for integrating these baselines.

2.6.2 Verification

Actions are taken to verify and document the completion of authorized activities, compliance to mission requirements, and adherence to the safety basis. Verification techniques may include performance assessments, audits, tests and demonstrations, and periodic reviews. Verification provides the means for identifying deviations from the baseline. Recognizing these deviations enhances the ability to make corrections and adjust the progress of the Project or the operation of the system.

Verification documentation may take the form of activity closeout correspondence, performance indicators, or technical papers providing the results of development. This documentation provides the basis for recognizing compliance with the baseline and for authorizing additional work to be performed by the prime contractor and subcontractors. This documentation also provides the rationale for how the system and Project evolve.

2.6.3 Improvements

Improvements to the Project baseline are conducted through established change control mechanisms described in Sect. 3.5 of the SEMP. Assessment criteria of proposed baseline improvements may include health, safety, and environmental risks as well as business risks (cost, schedule, feasibility of success, change in Project mission, etc.).

3. PLANNING AND CONTROL

The tools and techniques described in this section are used to plan, execute, and control the Project and operate the system. The rigor with which these tools and techniques are applied is based upon the hazards and risks within the scope of the Project and upon the desired quality of the Project work. The tools and techniques are segmented into:

- risk management,
- work control,
- interface control,
- performance measurement, and
- configuration management.

3.1 RISK MANAGEMENT

Risk management is used to ensure that activities and components within the system and scope of the Project are within the agreed-upon safety envelope. The safety envelope is also referred to as the safety basis or the safety management baseline. Risk management consists of establishing the agreed-upon safety envelope, and planning and executing work to ensure that the system and Project remain within the documented safety envelope. Risk management also consists of reviewing system operations and progression of work to ensure that activities and conditions are projected to remain within the safety envelope.

3.1.1 Establishing a Safety Envelope

The process for establishing the safety envelope is described in DOE Order 5480.23.[16] The standards used to develop the envelope include DOE-STD-3011-94 and DOE-STD-3009.[17, 18] The safety envelope is documented in safety analysis reports[10, 11, 12] and DOE acceptance correspondence. Conditions and controls for maintaining operation within the safety envelope are provided in technical safety requirement documents.

Establishing and maintaining a documented safety envelope is necessary to comply with system requirements 1.1.2 (*Identify and document hazards*) and 1.1.3 (*Document risks and controls*). Resources are requested by the prime contractor and authorized by DOE to maintain a documented safety envelope.

3.1.2 Operating within the Safety Envelope

The UF_6 Cylinder Project uses the Integrated Safety Management System (ISMS) approach for integrating safety into all aspects of work planning and execution. Bechtel Jacobs Company has established and submitted for DOE approval a protocol for how ISMS integrates into project management.[1] The objectives of this approach are:

- systematically integrate safety and environmental protection into management and work practices at all levels;
- accomplish work while protecting the workers, the public, and the environment; and
- ensure continuous improvements of existing systems and processes for performing work safely.

The foundation of the Cylinder Project approach to implementing an ISMS is the multi-site procedures process. The procedures process includes functional job analysis and Hazard identification. Procedures are written to describe how to safely perform the work and control the hazards. Workers are trained to the procedures via performance-based training. Workers are involved at all levels of the process.

Resources necessary to maintain the system within the safety envelope are requested by the prime contractor and authorized by DOE. The level of resources requested and authorized correspond to maintaining the conditions and controls specified in the safety envelope documentation. These controls also include the necessary activities to maintain compliance with system requirements 1.2.1 (*Implement safety controls*) and 1.2.2 (*Monitor and evaluate performance for potential risks*).

Technical requirement 1.1.3.f (*Incorporating ALARA*) will be factored into operation within the safety envelope through planning and development. It is recognized that this Project has relatively low hazards; therefore, emphasis is placed on minimizing the frequency of exposure to hazards (i.e., controlling operator hours spent in the storage yards and controlling the number of cylinder movements).

3.1.3 Forecasting Adherence to the Safety Envelope

Technical data regarding the condition of cylinders and information regarding the safety performance of activities (e.g., occurrence reports, injuries, and Unreviewed Safety Question Determinations) will be reviewed periodically. This information will be used to forecast the potential deviations from the safety envelope and to recommend improvements in the Project.

3.2 WORK CONTROL STRUCTURE

The prime contractor establishes a WCS and uses it to plan and control the scope of work within the Project. The WCS consists of a WBS, including a WBS dictionary, and integrated specification and performance trees. The WCS is documented in the PMP.

3.2.1 WBS

The WBS organizes the scope of work into manageable elements. The WBS is integrated with the planning and budgeting cycle needs such that areas of authorized work are easily identified within the WBS.

3.2.2 WBS Dictionary

A WBS dictionary is documented to assist in communicating to involved personnel the scope of work for the Project. The dictionary defines the scope boundary of each element allocating the required activities in the SEMP to WBS elements. The allocation of required activities complies with system requirement 5.2.1 (*Trace requirements to implementing documentation*) and demonstrates the flowdown of Project mission and major objectives into organized work. Related work elements are identified in the dictionary to facilitate integration of work activities. The WBS element incorporates prioritization of the required activities , and it identifies prime contractor organizations responsible for completing the activities. Prime contractor personnel use the dictionary in the planning and budgeting of work.

3.2.3 Specification Tree

The specification tree designates the methods (subcontract vehicles, policies, procedures) for accomplishing authorized work. Methods of accomplishment identified in the specification tree are connected to corresponding WBS elements. The specification tree demonstrates how the prime contractor controls work authorization and performance. The specification tree includes methods the prime contractor uses to verify work completion and/or compliance.

Electronic databases are used to maintain the vast quantity of cylinder related information. These databases may be used to plan and execute work. In addition, these databases may be used to verify work scope and work completion. Where appropriate, the use of databases such as UF_6 Cylinder Location, Inspection and Maintenance (UCLIM) is specified in work controls.

3.2.4 Performance Tree

To illustrate progression of the Project toward fulfilling its mission, planned (long-range) and authorized (fiscal year) performance are integrated into the WBS via the performance tree. Project and system performance metrics (cost, schedule, technical performance, and DOE deliverables) are identified in the performance tree and linked to corresponding WBS elements. The performance tree demonstrates the expectations for Project completion.

3.3 INTERFACE CONTROL

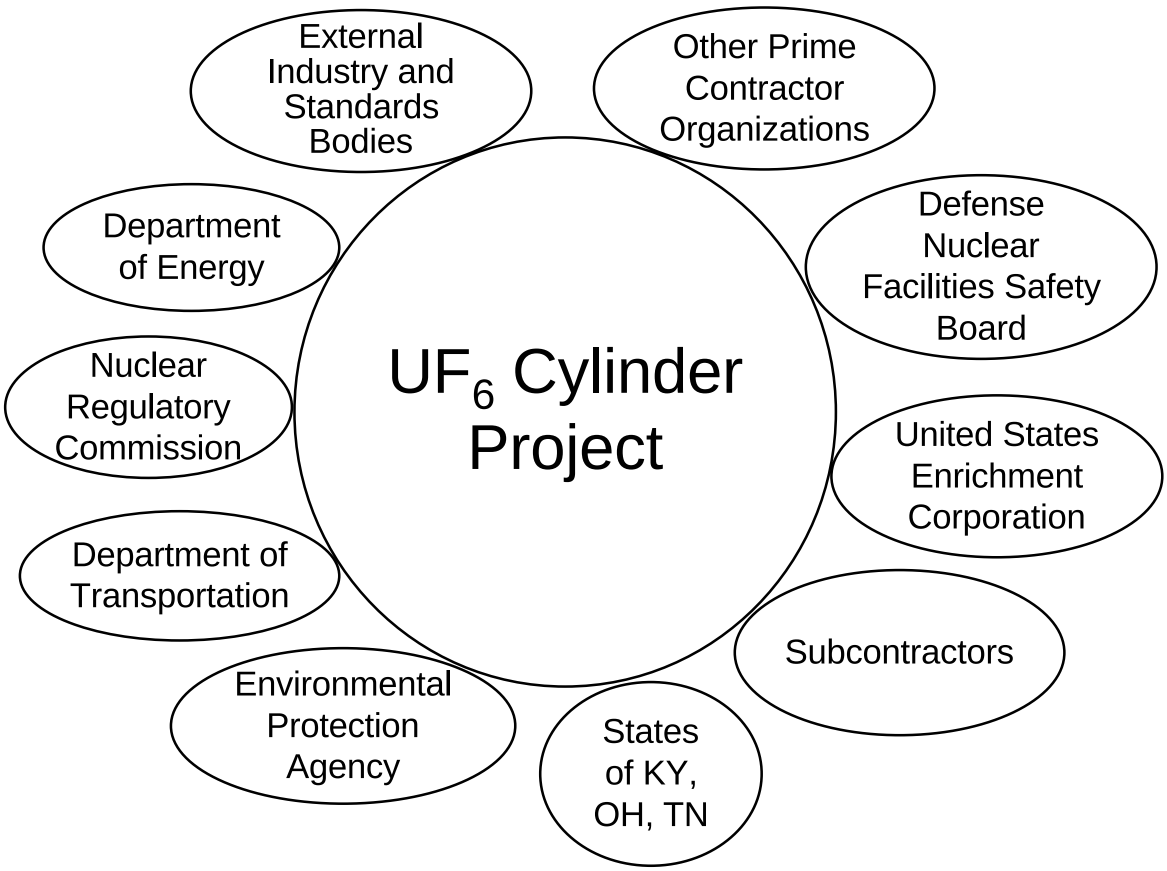
The purpose of controlling interfaces within the Project is to ensure that Project activities are integrated and the system remains functional. Interface control is segmented into oversight organizations, performing organizations, and system components and activities. To facilitate interfacing among organizations, the prime contractor has established roles and responsibilities. To facilitate interfaces among components and activities, the prime contractor will conduct functional analyses as described in Sect. 2.2. Functional analyses will identify critical interfaces and will document interfacing specifications of components and activities.

3.3.1 Oversight Organizations

Figure 3.1 identifies primary organizational interfaces with the Project and may affect the accomplishment of the Project activities. These interfaces are defined by federal and state regulatory standards, rules and statutes, memorandums of agreement, contracts, and statements of work. Periodical briefings, shared information, reports, and monitoring of proposed changes in regulations and rules between organizational interfaces will occur to assess the impacts on the Project mission.

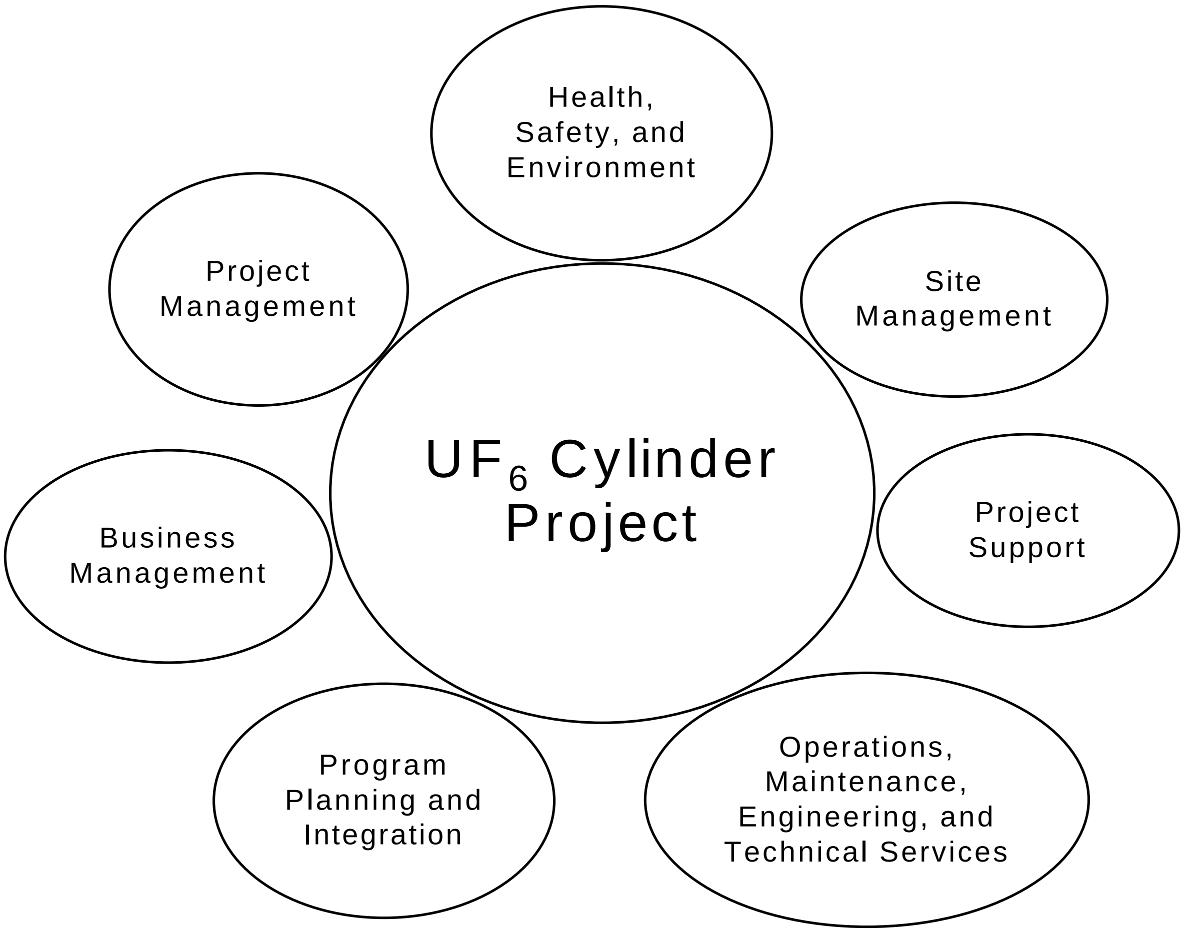
3.3.2 Performing Organizations

Figure 3.2 identifies the performing organizations that comprise the Project. Interfaces with subcontracted work are controlled through contractual vehicles identified in the specification tree. Interfaces within the prime contractor are managed via documenting roles and responsibilities. Interfaces within the Project management are specifically controlled by documenting in the PMP the roles and responsibilities of the Project management personnel.



CYLFIGSP.PPT

Fig. 3.1. External organization interfaces.



CYLFIGSP.PPT

Fig. 3.2. Performing organization interfaces.

3.3.3 Components and Activities

Safety analyses identify the safety-significant activities and components within the system. Functional analyses of these components and activities will identify the essential interfaces. These interfaces will be controlled by establishing and adhering to interface specifications.

3.4 PERFORMANCE MEASUREMENT

The purpose of performance measurement is to monitor the progression of the Project toward accomplishing its mission. Performance measurement is initiated in the planning stages of the Project by determining what metrics are appropriate to monitor the system and Project as a whole and what metrics are appropriate to monitor more detailed elements of the Project and system. The planning exercise establishes the baseline of expected performance. Project characteristics to be considered in establishing performance metrics include safe operations, financial expenditures, and the progression of activities. Execution of the Project plans includes monitoring and reporting progress per the pre-established performance metrics.

3.4.1 Monitoring Performance

The performance of the Project and of the system are monitored by Project management. The frequency of monitoring is determined by the frequency in potential change of the metric and the significance of the potential change. In general, costs and activities are monitored at least weekly.

3.4.2 Reporting Performance

The prime contractor reports performance to DOE monthly for designated performance metrics. This reporting includes a review meeting, and formal correspondence that identifies deviations from baseline expectations. Subcontractor personnel report performance to the prime as identified in the contract vehicles. The timing of subcontract reporting is in support of the reporting to DOE.

3.5 CONFIGURATION MANAGEMENT

Configuration Management of the Project is used to establish, control, and monitor baselines within the system. Baselines are agreed-to conditions and characteristics that the components and/or activities in the system should maintain or achieve. These baseline agreements are between DOE and the prime contractor. The mechanisms used to manage baselines are unique to the baseline being managed. As described in Sect. 2.6 the system has three baselines: a work progression baseline, a mission requirements baseline, and a safety management baseline. As required in the baseline agreement, activities and subsequent documentation to verify compliance may be necessary. These verification methods are described in Sect. 3.2 and Sect. 3.4.

3.5.1 Work Progression Baseline

This agreement authorizes the scope of work and funding resources for the fiscal year. This baseline includes key deliverables the prime contractor has agreed to provide DOE during the fiscal year. The prime contractor, Enrichment Facilities Organization, is responsible for establishing and controlling this baseline agreement. This organization is also responsible for reporting the progression of this baseline. The prime contractor UF_6 Cylinder Project organization is responsible for completion of the activities in the baseline plan. The control mechanism with specific responsibilities is documented in the baseline document or supporting documentation, Uranium Program Baseline Plan. The work progression baseline is maintained for the fiscal year.

To integrate the work progression baseline with the mission requirements baseline, the prime contractor UF_6 Cylinder Project organization may develop detailed Project plans including specific activities, costs, and schedules. These plans facilitate the planning and control of work progression. Detailed plans developed by this PE organization include the PMP and the EDP. The prime contractor uses a change control process for the documents. Project management has control authority within the bounds of the Uranium Program Baseline Plan commitments.

3.5.2 Mission Requirements Baseline

This agreement establishes the requirements (essential characteristics of activities and components) of the system used by the Project to accomplish the Project mission. The UF_6 Cylinder Project organization is responsible for establishing the requirements and for negotiating and reaching agreement with DOE on the requirements. The process for developing the mission requirements is described in Sect. 2. Change control is accomplished by proposing changes (either from the prime contractor to DOE or from DOE to the prime contractor) and negotiating an agreement. Proposed changes and the purpose for changes are documented, and written approval of revisions is required. Changes in the requirements baseline are maintained for the life of the Project. The mission requirements baseline is documented in the SRD. The SEMP provides the basis for how the Project is managed to achieve these mission requirements. Change control of the SEMP is administered in the same manner as the SRD.

Remaining cognizant of changes and evolution in standards referenced in the SRD is the responsibility of the prime contractor. Changes are monitored primarily by the compliance and support organizations of the prime contractor. Changes in the standards referenced in the SRD are accommodated in the same manner as other SRD changes. However, changes in the contractual standards identified in the prime contract may need to be revised prior to the revisions of the standards referenced in the SRD.

3.5.3 Safety Management Baseline

This baseline is established, authorized, and controlled in accordance with DOE Order 5480.23. This baseline is maintained for the life of the system. The baseline is documented in Safety Analysis Reports.[10, 11, 12]

Safety-related requirements may necessitate configuration management of components and activities. This control is the responsibility of the prime contractor implementing site organization. Specifically, the Project manager at the site is responsible for meeting the safety-related requirements and thus is a key participant in the change control process. To demonstrate compliance with the safety management baseline, the Project manager directs monitoring activities. The prime contractor establishes procedures for safety-related configuration management, including change control. These procedures are identified in the specification tree of the work control structure described in Sect. 3.2.

Because the Project is located at three sites, the three-site Project manager or designee is a member of the configuration control boards at each site. The three-site Project manager ensures change control consistency among the three sites within the scope of the Project.

3.5.4 Essential Documents

Four types of documents must be maintained in order to ensure effective Configuration Management of the Project and system. The types of documents and examples are shown in Table 3.1.

Table 3.1. Examples of essential documents

Type of document	Work progression	Mission requirements	Safety management
verification	Functional Area Monthly Status (FAMS), fiscal year closeout report	assessment, audit reports	Unreviewed Safety Question Determinations
baseline	Baseline Program Plan for Uranium Program Activities Oak Ridge Operations	SRD	Safety Analysis Reports (SARs)
implementation	subcontracts, procedures	EDP, PMP	Technical Safety Reviews (TSRs)
system/project basis	previous year’s closeout report	Requirement Analyses Reports, SEMP, development results	Process Hazard Analyses (PrHAs), Preliminary Hazard Assessments (PHAs)

4. SPECIALTY ENGINEERING

In the development of a system, many secondary factors must be integrated into the design and construction of the physical components and activities that the system comprises. Secondary factors are those aspects that do not drive the development or purpose of the activities or components in the system, but rather, support them, making the component or activity interactive with other system elements. These secondary factors are incorporated into the system design and construction through the Systems Engineering process via integration of engineering specialties. Specialty engineering disciplines play an important role in end product compliance to requirements. Engineering specialities for this system include reliability, maintainability, human factors, environmental issues, and safety.

The general status of the Project is beyond the design and construction phase of the system. The Systems Engineering effort for the Project focuses improving and integrating the existing elements of the system. Therefore, the establishment of rigorous plans to integrate specialty engineering is not justified. Some system elements are not fully integrated within the system and must be modified. Specialty engineering aspects for these elements are integrated into the analysis of options by way of the evaluation criteria. Evaluation criteria for the selection of modifications to the system include criteria for the following specialty engineering disciplines:

- Reliability,
- Maintainability,
- Human Factors,
- Environmental Issues, and
- Health and Safety.

Other engineering aspects typically considered specialty disciplines from a Systems Engineering perspective are integrated into the Project as major factors for the establishment and control of the system. These other engineering aspects include safety, performance measurement, contamination control, corrosion control, and quality assurance. For example, quality assurance is integrated with the Systems Engineering approach through the verification requirements set forth in Sect. 2 and Sect. 3.

For all decision making within the Project, the UF_6 Cylinder Project Manager has the authority to assemble a team of individuals with expertise in areas pertinent to Project activities. Typically, these teams would be ad hoc advisory groups dedicated to an evaluation of a specific decision, activity, or document. Examples might reasonably include peer reviews of reports or results interpretations, evaluation of implications of specific results or techniques, and efforts to facilitate sequencing of development activities. Advisory groups may be assembled to review and comment on requirements analyses and justification of pending decisions.

5. REQUIREMENTS ANALYSIS

The system requirements structure is illustrated in Fig. 5.1. The requirements analyzed are provided in Appendix A. The requirements in Appendix A include both system and subordinate technical requirements agreed to by the prime contractor and DOE. They are derived from the Project Mission, Major Objectives 1 through 5, and Requirement Categories 1.1 through 5.2. System requirements are in bold, italic type (e.g., ***1.1.1***) . Applicable technical requirements are denoted by alphanumerical characters following applicable system requirements numbers (e.g., 1.1.1a).

The requirements analysis process is described in Sect. 2.3 and illustrated in Fig. 2.3. Disciplines used to accomplish the first iteration of the initial requirements analysis included operations personnel, system engineers, and requirement-related subject matter experts. The second iteration was accomplished by system engineers, and a final integration was accomplished by Project representation and subject matter experts. Subsequent requirements analyses are to be completed by disciplines designated by Project management. Disciplines that may be used include systems engineering, project management, and appropriate subject matter personnel.

The initial requirements analysis was completed for the system requirements. Technical requirements were addressed by linking them to required activities identified as a result of the system requirements analysis. The initial requirements analysis began with the allocation of requirements to system operational functions and identification of evaluation criteria. To identify activities necessary to comply with system requirements, the following five steps were taken:

1. Analyze the optional methods for meeting the requirement.
2. Define the baseline configuration.
3. Implement the baseline configuration.
4. Verify compliance with the requirement.
5. Adjust the baseline to meet the requirement.

The first standard activity may not have been applicable to every system requirement. Subsequent improvements in this list of activities include prioritization of the activities based on the current operable state of the system, allocation of required activities to WBS elements, and identification of prime contractor organizations responsible for completing each activity. Improvements were made in the allocation of required activities to the EDP or PMP for implementation. Improvements in required activities were also made to respond to DNFSB comments.

Activities were assigned a priority ranking of 1 to 4, with 1 representing the highest priority. To facilitate this prioritization, the hierarchies of major objectives and requirement categories (Figs. 5.2 and 5.3) were used as guides. Summary level SEMP activities, those with only 4 digit numbers, are not ranked and therefore do not have priority numbers. The rational for not ranking these summary level actions is that the subordinate, more detailed activities drive the prioritization of work not the summary activities.

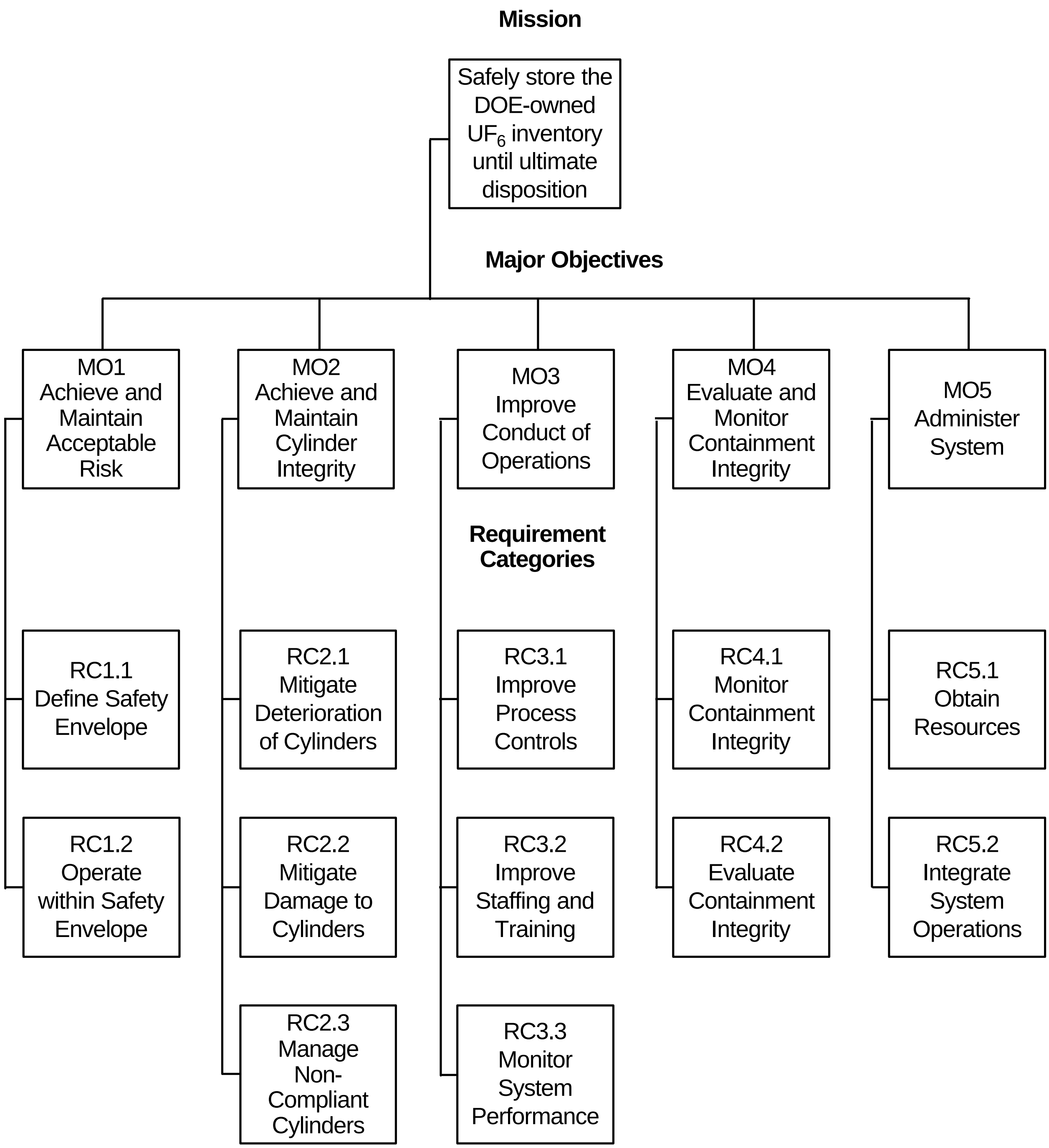


Fig. 5.1. System requirement structure.

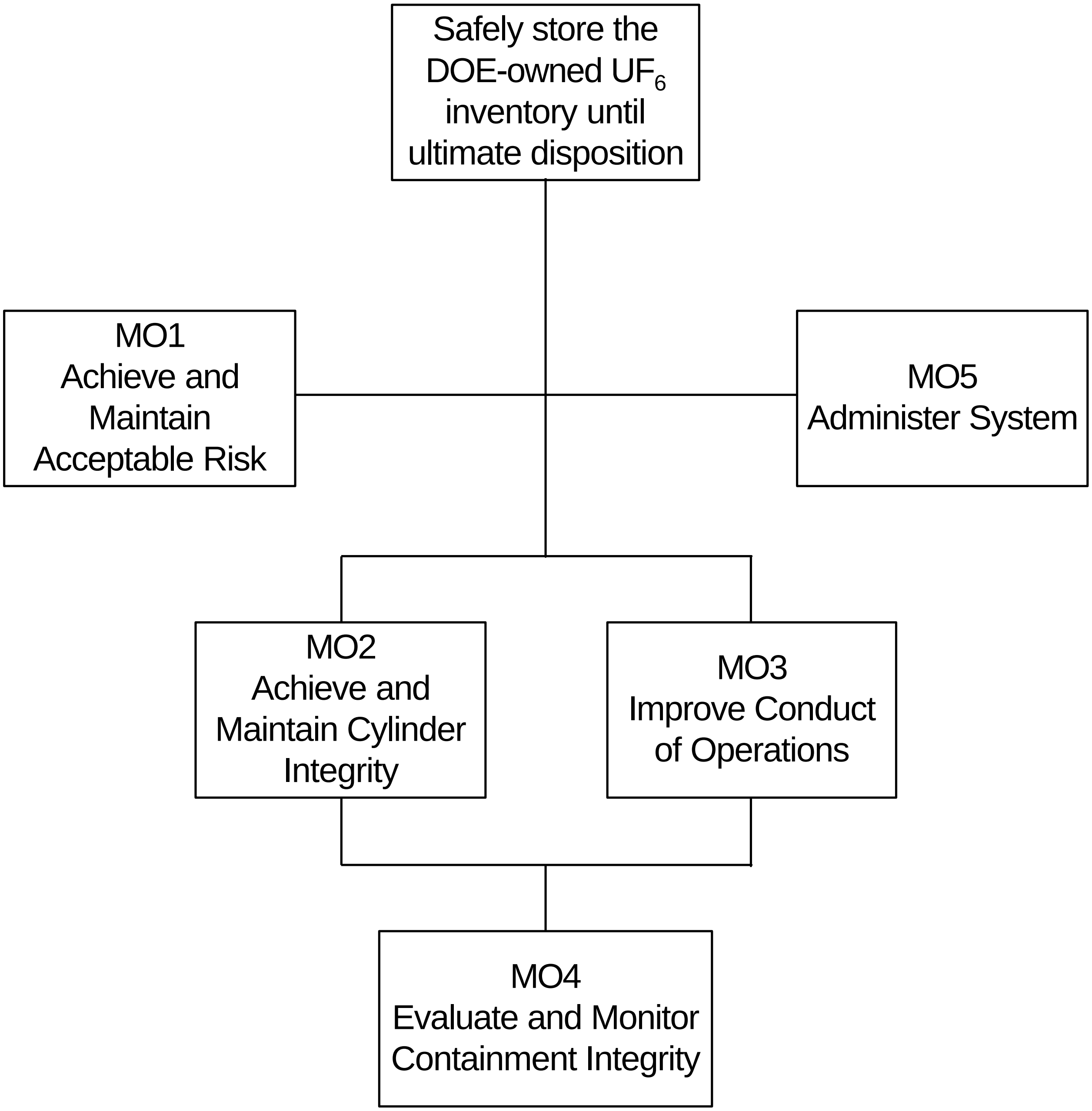


Fig. 5.2. Hierarchy of major objectives.

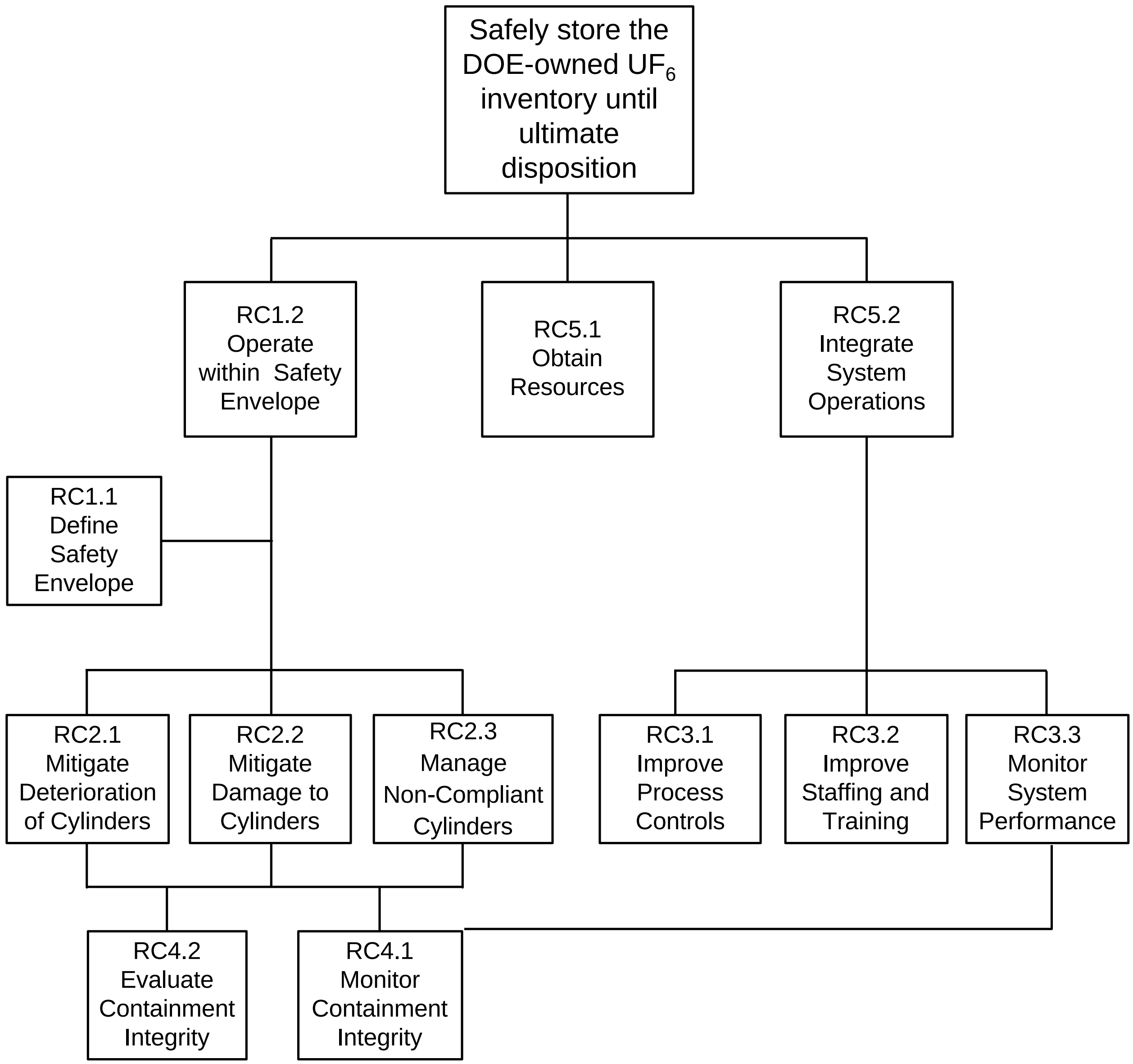


Fig. 5.3. Hierarchy of requirement categories.

The MO hierarchy shown in Fig. 5.2 represents the relationship of the 5 MOs. With the most summary level MOs being highest on the figure, closer to the mission statement, and the subordinate MOs being further down the diagram. This figure expresses the importance of each MO in accomplishing the Project mission. The MO ranking shown in Fig. 5.2 is based on the mission statement, the root cause analysis provided in the Implementation Plan to the DNFSB, and the current situation analysis documented in the SRD.

The rationale established major objective hierarchy is provided below. The emphasis of the mission statement is safety; therefore, the most important major objective is MO1 Achieve and Maintain Acceptable Risk (safety management). However, from the root cause analysis obtaining resources including financial and technical resources must be achieved to determine the risks and institute appropriate controls; therefore, MO5 Administer System is considered equally as important as MO1 to achieve the mission. Logically, the controls cannot be instituted and maintained without allocating resources to the Project. Ranking these MOs at the top also supports preservation of the safety basis and retention of technical competency within the Project, a systemic criticism of DOE facilities. It is anticipated that when the storage system is brought up to the baseline configuration (i.e., cylinders are placed on concrete storage yards, with appropriate spacing and corrosion protection) the hierarchy of MO5 will change and become less of an emphasis for the Project.

Based on the response to the DNFSB Recommendation 95-1[6] second emphasis is placed on improving the conduct of operations (controls for mitigating cylinder damage, i.e., sub-recommendation 2) and mitigating cylinder deterioration (paint cylinders, i.e., sub-recommendation 1). These emphasis areas correspond to MO3 Improve Conduct of Operations and MO2 Achieve and Maintain Cylinder Integrity respectively. The rationale for making these MOs subordinate to MO1 and MO5 is that they are less encompassing objectives and are more focused on how to manage risk and the system in general. These MOs are key to mitigating the root causes of the current condition of the system. Equal ranking is placed on MO2 and MO3 because there is no basis for ranking one of these two MOs higher than the other.

MO2 and MO3 were prioritized above MO4 for two reasons. One, the Project has current deficiencies making long-term risks higher than acceptable. Second, the Project risks have been defined sufficiently to establish a safety envelop for the Project. Using the rationale that mitigating actions have a greater impact on reducing and controlling hazards than surveillance activities, MO4 has been given a lesser ranking. Also supporting this rationale is that degradation of containment integrity is slow.

The hierarchy of the requirement categories shown in Fig. 5.3 follows the same rationale as the logic provided for the ranking of MOs, with one more detailed ranking added. With the mission statement being active "safely store" a greater emphasis is placed on operating within the safety envelope, RC1.2, than defining the safety envelope, RC1.1. This distinction established a four tiered hierarchy for the requirement categories. An existing safety envelope supports this distinction. The rationale for not making RC1.1 lower in the hierarchy is that the safety envelope is dynamic and needs continual updating as the project evolves.

The results of the initial system requirements analysis are provided in Appendix B. The product of the requirements analysis is a list of comprehensive activities necessary to meet the system and technical requirements. The tables in Appendix B trace the system requirements and associated standards from the major objectives to required activities.

6. NEXT STEPS

The next steps in the Systems Engineering approach are organizing required activities into work packages, and sequencing and scheduling the activities for completion. This section provides the general guidelines for sequencing and scheduling the SEMP activities.

To implement the SEMP-stated activities, it is necessary to identify activity sequencing constraints. In addition, specific work plans need to be developed, prioritized, and scheduled for completion. Current activities within the existing system need to be integrated with the SEMP-stated activities. This planning exercise is accomplished in the development of the PMP and EDP. To aid in the planning exercise, relationships among SEMP activities have been identified (see Appendix B).

6.1 PRIORITIZATION

The general guidelines identify the factors to be considered as constraints and priorities for completing the SEMP-stated activities. These guidelines are based on the assumptions established in the SRD. The primary bounding assumption is that the current containment integrity of cylinders presents no imminent risk to the environment, the public, or plant workers. This assumption permits the Project to initiate some degree of planning, testing, and evaluation prior to the implementation of corrective activities. However, because past practices have resulted in reduced containment integrity, it is necessary that the Project initiate immediate and interim measures to reduce current risks. This situation establishes the need for staging and prioritizing activities as follows:

1. Implement activities to mitigate obvious unacceptable risks (i.e., remove heavily corroded cylinders from ground contact, batch breached cylinders, stop leaking valves).
2. Define/develop a preferred system configuration. The preferred system configuration includes, but is not limited to, defining an acceptable storage array (i.e., concrete storage yards, nominal 4 ft. isle spacing) and an appropriate Project management structure (i.e., systems engineering approach, roles and responsibilities, cylinder information computer systems).
3. Implement the preferred configuration. Implementation refers to adjusting the current configuration (gravel yards, inaccessible cylinders, UCLIM computer system) to the preferred configuration as stated above (including publishing the systems engineering documents).

Specific prioritization is based on risk management decisions through the use of the risk reduction matrix. The hierarchies of major objectives and of requirement categories (Figs. 5.2 and 5.3, respectively) are also used in prioritizing activity schedules. As a result, immediate activities specified in the SEMP (such as activities 2.1.1.3.1, 2.1.2.3.1, 2.1.3.3.1, and 2.1.4.3.1) are priority activities.

6.2 CONSTRAINTS

Constraints on the Project are established in the bounding assumptions within the SRD. More specific constraints are as follows:

- near-term funding allocation to the Project;
- near-term equipment and facility resources to move cylinders, store them in acceptable facilities and remove non-compliant cylinders from the system;
- limited technical basis documentation for the current technical configuration;
- cylinder-specific corrosion knowledge limited to characterization to date and industry-related experience and expertise.

The above constraints are considered in the planning and annual decision making of DOE approved Project activities. They applied to near term activities and schedules including development activities and activities to mitigate current risks that may impact safe storage. Out-year activities and schedules may be impacted by changes in DOE funding priorities and the congressional budget.

6.3 SEQUENCING

The sequencing of activities is generally provided in the systematic approach used to identify the activities. For each requirement, activities are identified to analyze the optional methods for meeting the requirement, to define the method and subsequent configuration to achieve requirement compliance, and to implement the configuration. This systematic approach provides the basis for logical sequencing of activities. For sequencing activities outside a specific requirement, the same logic will be used in sequencing. During the configuration implementation and/or revision stages, optimization studies may be necessary to efficiently accomplish the preferred configuration. The process for optimizing implementation is described in Sect. 2.3.2 of this document.

6.4 PROJECT MILESTONES

Major milestones and milestones must be met if the Project is to comply with the preferred system configuration established through the Systems Engineering approach. These major milestones and milestones include:

1. Define and document the system configuration.
    - 1.1 Define the cylinder acceptance criteria and their relationship to industry standards.
    - 1.2 Fully define and authorize a safety basis.
    - 1.3 Define and document the remaining system configuration.
2. Determine compliance with defined configuration.
    - 2.1 Assess the cylinder inventory to acceptance criteria.
    - 2.2 Assess the storage facilities to acceptance criteria.
    - 2.3 Assess the system functional flow with functional requirements.

3. Comply with the preferred system configuration.
    3.1 Place all cylinders in acceptable storage facilities.
    3.2 Establish a coating on all cylinders.
    3.3 System performance assessments identify no critical non-compliances with preferred system configuration.

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GLOSSARY

Activity—Organized, supervised actions or movements as distinct from mere existence or state (i.e., components). Activities are the lowest level of functional decomposition.

Allocation—A designation or apportionment of functions or requirements into subsystem levels. Allocation is performed to trace requirements and the division of the system down to the activity and component level.

Analysis of Alternative—Synthesized options to meeting a requirement. The synthesis is performed to evaluate and select a preferred option, method, and strategy for meeting a requirement. Tools used in the options analysis include trade studies, tests, demonstrations, feasibility studies, and cost—benefit analysis.

Baseline—The established expectations against which the performance (cost, schedule, status, and progression) of the system can be assessed. Baseline documentation consists of spending schedules; performance milestones; and configuration documentation, such as design drawings and work authorization processes.

Basis—Justification, including analyses and experience, for the arrangement of the system and performance specifications. Basis documentation includes but is not limited to physical and chemical properties of the components and analytical results from development studies, such as hazard assessments and risk analyses.

Change Control—A formal control of the system configuration alterations including the review, concurrence, approval, issuance, and distribution of baselines and other controlled documents.

Command Media—Any document intended to control work activities. This includes procedures, program descriptions, work permits, job aids, etc.

Component—The lowest level constituent part of hardware, financial resources, organizations, humans, and software specified in dividing the system into manageable elements.

Configuration—The relative arrangement and condition of components and activities that comprise a stable system. This arrangement and condition describe the functional flow and physical characteristics of components and activities that combine to demonstrate technical and managerial adherence to system and technical requirements. The configuration is documented in the system baseline documents and system basis documents, which provide the form, fit, and function of components and activities.

Configuration Control—The controlling activity of configuration management to develop and maintain a system configuration that adheres to the system and technical requirements.

Configuration Item—A component or activity necessary to operate the system safely.

Configuration Management—The identification of configuration items, the control of their developing and established baseline, and the assessment of operational and developmental status to baseline.

Control—The act of restraining or directing influence over activities usually accomplished by using mechanisms that guide or regulate the operation of machines, apparatus, or system.

Element—A distinct part of a composite device or Project.

Evaluation Criteria—Factors to be considered in synthesizing, evaluating, testing, and selecting methods and strategies of accomplishment.

Function—A group of activities contributing to a larger activity and purpose.

Functional Allocation—The act of apportioning the activities and components into functions for describing and managing the system flow.

Functional Analysis—The analysis of a defined function to determine all subfunctions necessary to accomplish the purpose of that function. Functional analysis also provides the means for identifying the requirements that the functional activities and components must satisfy to have an operable function. Functional analysis includes the identification of needed subfunction, component, and activity interfaces.

Manage—The act of exercising executive, administrative, and supervisory direction of activities for accomplishment of a purpose. Management are personnel responsible for overseeing the development and execution of the system such that it accomplishes the mission, and major objectives set forth in the Project.

Performance—The execution of an activity described in sufficient detail to determine if the activity accomplished its intent.

Phase—A part of the life cycle of the system which typically describes the system in terms of the beginning to end (i.e., design, construction, start-up, operation, standby, decontamination, decommission). For the UF_6 cylinder system the life cycle is described in terms of design, construction, start-up, production, storage, material disposition, decontamination, and decommission. The current phase is primarily storage.

Program—A group of projects managed in a coordinated way to obtain benefits not available from managing them.

Project—A compilation of activities and components organized and deployed to accomplish a mission with a unique product or service. Projects have a distinct beginning and end. For the purposes of the SEMP the term *project* refers to the mission, major objectives, plans, and schedules to which the DOE inventory of UF_6 cylinders is managed.

Requirement—Something essential to the existence or occurrence of something else; characteristics that identify the accomplishment levels needed to achieve specific objectives for a given set of conditions.

Requirements Analysis—The examination of specified characteristics identified as requirements for the system to determine the necessary activities and components to make the system operable.

Risk Management—An organized, analytical process to identify what can go wrong, to quantify and assess associated risks, and to implement/control the appropriate approach for preventing or handing each risk identified.

Safety Envelope—The system boundary conditions from which identified hazards and risks are analyzed to determine minimum controls for safe operation. The safety envelope is supported by a documented safety basis.

Segment—A separate piece of system defined to facilitate its management. Segments are defined in this Project as operations, development, and administration.

Specification—A document that clearly and accurately describes essential technical information and verification procedures for items, materials, services, and activities. Specifications are used to support acquisitions and life cycle management. Contracts are a form of specifications identifying the who, what, where, when, how, and how much parameters for accomplishing work.

Standard—A definite rule or principle established by authority, custom, or general consent as a model or example to measure extent, value, or quality. Standards adopted by the Project create a structure that integrates the system into external entities. Where pre-established standards are not applicable to the Project, Project-derived standards are developed.

Synthesis—A translation of requirements into possible integrated solutions (i.e., subsystems, activities, and components).

System—A regularly interacting or interdependent group of items forming a unified whole; a group of interacting bodies under the influence of related forces that perform vital functions. The system used to achieve the UF_6 Cylinder Project goals is defined as the containment of the UF_6 and associated support functions to maintain containment integrity. System is distinct from the Project in that the system is the means for accomplishing the Project tasks, objectives, and mission.

System Engineering—A comprehensive, iterative problem-solving method that is used to make the system accomplish the Project goals. This method systematically identifies the Project needs, establishes a system to accomplish these needs, and instills the controls for maintaining adherence to Project objectives.

Verification—A completion step in the development and execution of activities to ensure progress is compliant with the intent and purpose of the planned task. The tasks performed to evaluate progress and effectiveness of products to measure specification compliance. For example, activities determined necessary to meet a specified requirement are verified completed to ensure the requirement is being meet.

Work Control Structure (WCS)—A composition of the work breakdown structure, specification tree, and performance tree used in the control of progress.

Work Breakdown Structure (WBS)—An organization of work tree composed of components (hardware, software, personnel, etc.) and activities (cylinder movement, inspection, painting, etc.) developed to divide work to manageable control points.

APPENDIX A. SYSTEM AND TECHNICAL REQUIREMENTS

Key standards are identified in brackets [   ] after each requirement. A comprehensive allocation of standards to requirement categories is provided in Appendix B of the SRD.

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISK

1.1 Define the Safety Envelope

1.1.1 The Project technical configuration shall be defined and documented.

1.1.1a The functional relationships shall be identified to establish continuity of the system. [10 CFR 830.120]

1.1.1b Storage history for each cylinder shall be documented and maintained for the service life of the cylinder. [10 CFR 835, DOE 5633.3B]

1.1.1c Functional relationships shall be documented. [10 CFR 830.120]

1.1.2 Project hazards shall be identified and documented.

1.1.2a The system hazards shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.7A, DOE 5480.22,, DOE 5480.23, DOE 6430.1A, ANSI 8.1, 8.3, 8.7, 8.20]

1.1.2b The hazards documented in the safety basis shall be periodically reviewed and updated to reflect a current definition of hazards within the system. [DOE 5480.21, DOE 5480.23, DOE 6430.1A]

1.1.3 The Project risk(s) and required controls shall be documented.

1.1.3a Maintenance and verification activities within each operational function shall be documented. These actions are to compensate for cylinders in the system that do not meet all functional acceptance criteria. These actions ensure the risks of processing cylinders from one function to another are sufficiently controlled.

1.1.3b The system risks and minimum controls shall be identified, evaluated, and documented as part of a complete safety analysis to define the safety envelope. [DOE 5480.7A, DOE 5480.22, DOE 5480.23, ANSI 8.1, 8.3, 8.7, 8.20, DOE 6430.1A]

1.1.3c The safety basis shall be periodically reviewed and updated, to reflect a current safety analysis and risks within the system. [DOE 5480.23, DOE 6430.1A]

1.1.3d Appropriate evaluations of compliance with the safety envelope shall be conducted when the safety basis in question due to changes in procedures, work scope, and/or storage configurations. [DOE 5480.21]

1.1.3e Appropriate reviews and assessments shall be performed to ensure the preparedness of new activities and facilities, and the restart of activities as appropriate. [DOE 5480.31]

1.1.3f The concept of as low as reasonably achievable (ALARA) shall be incorporated in the risk management and reduction efforts within the Project.
[10 CFR 835, 29 CFR 1910, 29 CFR 1926, DOE 6330.1A]

1.2 Operate Within the Safety Envelope

1.2.1 Required risk controls shall be implemented.

1.2.1a An industrial hygiene program shall identify and administer controls to ensure proper management of industrial hazards. [10 CFR 830.120]

1.2.1b Accountability of the inventory shall be managed through a NMC&A program. This program provides the assay and mass quantities necessary for controlling fissile material relative to criticality concerns.
[10 CFR 835, DOE 5633.3B]

1.2.1c Cylinders containing fissile material shall be segregated from non-fissile inventories and spaced in accordance with nuclear criticality control guidelines. [10 CFR 835, ANSI 8.1, 8.3, 8.7, 8.20, DOE 5633.3B]

1.2.1d The security of the UF_6 inventory shall be maintained in accordance with a safeguards and security program. This program specifies and maintains the periodicity of routine patrols and physical boundaries. The program also specifies other security specifications including lighting, as determined necessary.
[DOE 5633.3B]

1.2.1e Cylinder storage in ground contact shall be prevented. Temporary placement of cylinders on the ground during relocation and staging operations is acceptable, but should not exceed specified duration. [10 CFR 835]

1.2.1f Contracted organizations shall operate within an established safety envelope. [10 CFR 830.120, DOE 5480.22, DOE 5480.23]

1.2.1g Prioritization of deficiencies shall be used in the optimization of actions taken to reduce risks within the Project.

1.2.2 Performance shall be monitored and evaluated to identify potential risks within the Project.

1.2.2a Facility safety walk-throughs shall be conducted regularly to identify initiators and determine ameliorative actions. [10 CFR 830.120, 10 CFR 835, USEC-651]

1.2.2b The Project shall establish system performance indicators in critical areas to determine the effectiveness of activities. [DOE 4700.1, 10 CFR 830.120]

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

2.1 Mitigate Deterioration of Cylinders

2.1.1 A barrier between the cylinder mild steel containment surfaces and wetness shall be maintained.

2.1.1a A cylinder maintenance coating program shall be instituted to maintain cylinder coatings throughout the storage phase of the system. [10 CFR 830.120, 10 CFR 835]

2.1.1b The coating application and maintenance shall be prioritized and scheduled based on the knowledge of the present condition of the cylinder, the forecasted deterioration of wall thickness, and operational logistics with yard refurbishment, cylinder access, and location /density of priority cylinders. [10 CFR 830.120, 10 CFR 835]

2.1.1c Toughness, durability, and repair qualities shall be criteria in the review and acceptance of coatings and replacement coatings. [DOE 6430.1A]

2.1.2 Water retention on cylinders caused by cylinder structural features shall be minimized.

2.1.2a Skirt region drainage shall be promoted, to minimize corrosion. [10 CFR 830.120, 10 CFR 835]

2.1.3 Water retention on cylinders caused by cylinder support structures shall be minimized.

2.1.3a Cylinder saddles shall provide ventilation between the cylinder and the load-bearing surface. [10 CFR 830.120, 10 CFR 835]

2.1.3b Cylinder saddles shall facilitate proper drainage from the cylinder and storage facility. [10 CFR 830.120, 10 CFR 835]

2.1.4 Water retention on and adjacent to storage facilities shall be minimized.

2.1.4a Storage facilities shall be designed for the expected life of the storage phase of this Project and for the expected operational activities. [10 CFR 830.120, 10 CFR 835, DOE 6430.1A]

2.1.4b Cylinders shall be stored on load-bearing surfaces that, when in use, drain properly (as determined by the Project) and rigidly support handling equipment during operations. [10 CFR 830.120, 10 CFR 835]

2.1.4c Cylinders and supporting saddles shall be configured on storage facilities to facilitate proper drainage. [10 CFR 830.120, 10 CFR 835]

2.1.5 Cylinder valve and plug integrity shall be maintained to Project standards.

2.1.5a A valve and plug integrity management program shall be established to minimize potential hazards, through monitoring and corrective actions, associated with presence and failure of these components. [10 CFR 830.120, 10 CFR 835, USEC-651]

2.1.5b Failed valves and plugs including intermittent leaking shall be detected and corrected. [10 CFR 830.120, 10 CFR 835, USEC- 651]

2.1.5c Valves with missing or damaged parts shall be replaced or the parts replaced to meet functional criteria. [10 CFR 830.120, 10 CFR 835, USEC-651]

2.2 Mitigate Damage to Cylinders

2.2.1 Cylinder containment integrity shall be maintained during handling, processing, and transport operations.

2.2.1a A viable means to transport cylinders off-site that do not meet DOT standards shall be determined for foreseeable shipments.[1] [49 CFR, 10 CFR 830.120]

2.2.1b Maintenance and verification activities shall be implemented within each operational function to compensate for cylinders in the system that do not meet the storage vessel criteria. These activities ensure the risks of processing cylinders from one function to another are sufficiently controlled.[1]

2.2.1c Cylinder handling and stacking configurations that minimize potential impacts between cylinders shall be established. [10 CFR 830.120, USEC-651]

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[1]M. S. Taylor, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tenn., letter to J. W. Parks, U.S. Department of Energy, Oak Ridge, Tenn., Contract DE-AC05-84OR21400, Cylinder Project Requirement Analyses, March 27, 1997.

2.2.1d Engineering controls to reduce potential cylinder damage using existing equipment during stacking operations shall be evaluated. [29 CFR 1910]

2.2.1e The design of new handling equipment shall consider additional controls to prevent coating damage on the body of the cylinder and cylinder damage by operator error when lowering cylinders for placement. [USEC-651]

2.2.1f New saddle design shall include the protection of cylinder coating. [DOE 6430.1A]

2.2.1g Operational controls for handling cylinders shall incorporate additional precautionary measures for handling degraded cylinders. [DOE 5480.19]

2.2.1h An NMC&A program shall control, through authorization, the movement and processing of the UF_6 inventory. [10 CFR 835, DOE 5633.3B]

2.2.2 Cylinder handling, processing, and transporting equipment operators shall be proficient.

2.2.2a Operators shall be qualified to verify their proficiency in the use of such equipment. [10 CFR 830.120]

2.3 Manage Non-Compliant Cylinders

2.3.1 Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated service life and configuration. [ANSI N14.1, DOE 6430.1A, USEC-651]

2.3.2 Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions. [10 CFR 830.120, DOE 5480.23]

2.3.2a Operators shall be trained on the risks and hazards of handling UF_6. [10 CFR 830.120, DOE 5480.23]

2.3.3 Non-compliant cylinders shall be repaired or replaced to meet Project standards. [USEC-651]

2.3.3a The functional capacity to safely manage non-compliant cylinders shall be established in order to minimize the impact on the surveillance and maintenance function.

2.3.3b Methods for processing non-compliant cylinders shall be established as necessary. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]

MO3: IMPROVE CONDUCT OF OPERATIONS

3.1 Improve Process Controls

3.1.1 The system configuration (physical components, functions, and documents) shall be controlled through a formal process.

3.1.1a A configuration management process shall be instituted to control configuration items. [10 CFR 830.120]

3.1.2 Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process.

3.1.2a Procedures and work plans shall incorporate all the pertinent information (e.g., safety precautions, emergency response, lessons learned, and site specific requirements). [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2b Procedures shall be reviewed and updated, to ensure three-site consistency and elimination of any procedural contradictions to ensure sufficient and uniform risk management within the Project. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2c Any site-specific documentation requirements shall be identified and taken into consideration in the procedure process. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.1.2d Performance shall be periodically monitored and assessed to determine procedures are being followed. [10 CFR 830.120]

3.2 Improve Staffing and Training

3.2.1 Personnel shall be selected, trained, and developed through a structured process.

3.2.1a Personnel shall be trained to provide understanding of the safety documentation. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910, DOE 5480.23, DOE 5633.3B]

3.2.1b Personnel shall be trained and retrained at frequencies determined by the training organization considering the potential consequences of the task, the complexity of the task, and the frequency with which it is performed. [10 CFR 830.120, 10 CFR 835, 29 CFR 1910.120, DOE 5480.23]

3.2.1c A database shall be utilized to cross-link training requirements (including training to procedures and training intervals) to training records. The data base shall be used to maintain training records current with procedure revisions. [10 CFR 830.120, 10 CFR 835, DOE 5480.23]

3.2.1d A performance-based methodology shall be used for training. [10 CFR 830.120, DOE 5480.23]

3.2.1e Training modules shall incorporate all pertinent information (e.g., safety precautions, hazards, emergency response, lessons learned, and site specific requirements. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, DOE 5633.3B]

3.2.1f Performance shall be periodically monitored and assessed to determine the effectiveness of training. [10 CFR 830.120]

3.3 Monitor System Performance

3.3.1 System functions shall be monitored to reinforce expectations for work performance and facility condition.

3.3.1a Conduct of Operation principles shall be applied to functions and operations within the system, to ensure the performance of actions accomplishes the intent. [10 CFR 830.120]

3.3.1b Performance shall be periodically monitored and assessed, to determine that the intent of the operation is being fully met. [10 CFR 830.120]

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

4.1 Monitor Containment Integrity

4.1.1 Exposure to the environment shall be monitored.

4.1.1a Environmental monitoring actions within the storage phase shall be balanced with potential environmental remediation in the decommissioning phase.

4.1.1b Facilities shall be regularly surveyed for radiation and release of UF_6 and reaction products to evaluate Project risks. [10 CFR 835, DOE 5480.23]

4.1.2 Cylinder condition shall be monitored.

4.1.2a Cylinder functional acceptance criteria shall be defined to ensure safe operations within each system function. [10 CFR 830.120, 10 CFR 835, DOE 5480.23, USEC-651]

4.1.2b The applicability of industry standards, including ANSI 14.1 and the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code to operational functions shall be established. [10 CFR 830.120, 10 CFR 835, 49 CFR 173.420, DOE 5480.23, USEC-651]

4.1.2c Exceptions, as necessary, shall be obtained to maintain adherence with industry standards. [NBIC]

4.1.2d Inspection/evaluation methods for verifying compliance with functional acceptance criteria shall be developed and implemented to identify unsafe cylinders. [10 CFR 830.120, USEC-651, NBIC]

4.1.2e Cylinders shall be inspected on a risk-based periodicity to detect loss of containment. [DF&O]

4.1.2f Cylinders shall be properly spaced to facilitate inspection. [10 CFR 835, 10 CFR 830.120, USEC-651]

4.1.3 Factors that affect cylinder condition shall be monitored.

4.1.3a Environmental and other factors affecting cylinder integrity shall be identified and evaluated to determine their effect (e.g., localized corrosion mechanisms that involve crevice, galvanic, packing nut, and hydrogen fluoride–related corrosion; corrosion under channel-type stiffeners and head/skirt region; impact of brittle fracture on cylinder storage). This evaluation determines what factors need to be monitored for proactive management and preventive measures. The rigor of this comprehensive evaluation is based on the degree of effect on the containment integrity. [DOE 5480.23, DOE 6430.1A]

4.1.3b Cylinder degradation factors shall be monitored to collect forecasting and trending data. [10 CFR 830.120]

4.2 Evaluate Containment Integrity

4.2.1 Cylinders shall be categorized to ensure that risks are identified.

4.2.2 Cylinder conditions shall be forecast to direct surveillance and maintenance resources.

4.2.2a Specific information, as determined by the Project, shall be tracked to project the current and future conditions of the system. [10 CFR 830.120, DOE 4700.1]

4.2.2b Mechanisms to consolidate information for summary level decision-making determinations shall be developed. [10 CFR 830.120, DOE 4700.1]

MO5: ADMINISTER THE SYSTEM

5.1 Obtain Resources

5.1.1 Financial resources to sustain the system shall be obtained and utilized.

5.1.2 Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured.

5.2 Integrate the System Operations

5.2.1 System and technical requirements shall be traceable from the Project mission to implementing documentation.

5.2.2 The system configuration shall be optimized in accordance with life-cycle projections.

5.2.2a Impact on the subsequent Project phases shall be considered in changes to the system configuration including modifications to accommodate regulatory changes. [10 CFR 830.120, DOE 5480.19]

5.2.2b The planning for UF_6 dispositioning shall take into consideration the condition of cylinders and compensatory actions to accomplish disposition operations. [10 CFR 830.120]

5.2.2c As part of continuous improvement, other methods for reducing time of wetness and cylinder degradation shall be evaluated. [10 CFR 830.120, 10 CFR 835]

APPENDIX B. REQUIRED ACTIVITIES

The results of the system requirements analysis are provided in the following tables. The product of the requirements analysis is a list of comprehensive activities necessary to meet the system and technical requirements. These tables trace the requirements and associated standards from the major objectives to required activities. The numbering system corresponding to this tracing provides unique numbers for each major objective, requirement category, system requirement, technical requirement, and activity. The numbering system is defined as follows:

major objective	requirement category	system requirement	activity	subactivities	
X.	X.	X.	X.	X.	X.

Technical requirements subordinate to the system requirements are identified by the system requirement number followed by a unique alphanumeric identifier. Activities key to complying with the technical requirements are identified by technical requirements in [ ] following the activity statement. Where complete, the analyses of technical requirements are referenced in the list of requirements shown in Appendix A. These referenced analyses support the analyses shown in this appendix and document the rationale for how technical requirements are met.

A need for more detailed technical requirements analysis was identified in the following areas:

1. Additional fire controls[1]
2. Cylinder painting.[2]

The requirements analysis process was initiated and options were identified, analyzed, and selected for these areas based on the results of this process.

The selected options have been implemented through integration with the existing project.

The following tables trace the system requirements and associated standards from the major objectives to required activities. The tables also provide the following information:

- *Requirements Allocation*—After the requirement statements in ( ) are the operational functions for which the requirement is allocated.
- *Evaluation Criteria*—These criteria are used in evaluating more detailed activities to be developed by the Project management. The criteria ensure that the activities to be further detailed meet the intent of the requirement. Many criteria were developed from the issues identified in the DNFSB "TECH 4" report, to ensure the Project is responsive to DNFSB's concerns.

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[1] *Implementation of Additional Fire Controls Requirements Analysis,* Lockheed Martin Energy Systems, Inc.

[2] M. S. Taylor, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tenn., letter to J. W. Parks, U.S. Department of Energy, Oak Ridge, Tenn., Contract DE-AC05-84OR21400, Cylinder Project Requirements Analyses, March 27, 1997.

- *Implementation Allocation*—Each activity has been allocated to either the EDP or the PMP for completion. This designation is shown in the last column of the tables.
- *WBS Allocation*—To assist in the development of work packages under the WBS in the PMP and EDP, activities have been allocated to WBS elements.
- *Organization Allocation*—Each activity has been assigned to a prime contractor organization responsible for completing the activity. Project Execution (PE), Business Management (BM), Project Support (PS) and are the three organizations of the prime contractor. Project Integration (PI) is a responsibility of the Project Execution organization. Roles and responsibilities of these organizations are provided in the PMP.
- *Current Priority*—Based on the current status of the system, priorities for improvement are provided. Activities designated as "1" represent the highest priority. It should be noted that in keeping with applying systems engineering principles to an existing project, many of these SEMP activities have been addressed to some extent. The prioritization effort recognized the efforts accomplished to date and judged the value of additional work or improvements within the scope of the SEMP activity. Thus, the prioritization of SEMP activities cannot be correlated to the natural sequencing of activities.

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or(P)MP
	1.1.1		**The program technical configuration shall be defined and documented (continued)**		
1.5.2, 1.5.3	1.1.1.2.3.3	3	Document pertinent history of component use. [1.1.1.b]	PE	P
1.4.1, 1.4.2, 1.5.3	1.1.1.2.3.4	2	Improve the database that provides cylinder location, condition, content, maintenance, and history necessary to manage actions and constraints related to maintaining cylinder integrity.	PS	P
1.5.1, 1.5.2	1.1.1.2.4	2	Determine required baseline maintenance.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.1.2.4.1	2	Develop a baseline configuration management system. [1.1.1.b, 1.1.1.c]	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.1.2.4.2	2	Determine the intent and periodicity of configuration audits. [1.1.1.c]	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.1.2.5	2	Determine method to verify baseline meets requirement.	PI	P
1.4.1, 1.4.2	1.1.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.1.3.1	2	Implement configuration management system for system baseline. [1.1.1.c]	PE PS	P
1.5.1, 1.5.2	1.1.1.3.2	2	Implement configuration audits.	PI PS	P
1.5.1, 1.5.2	1.1.1.4		Verify compliance with this requirement	PE	P
1.5.1, 1.5.2	1.1.1.4.1	1	Enter documentation into the cylinder management document center references to actual design and manufacturing standards for existing cylinders.	PE	P
1.4.1, 1.4.2	1.1.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS

Requirement Category: 1.1 Define the Safety Envelope

Requirement: 1.1.2 Project hazards shall be identified and documented. DOE 5480.7A, DOE 5480.21, DOE 5480.22, DOE 5480.23, ANSI 8.1, 8.3, 8.7, 8.20, DOE 6430.1A; (F:All)

Evaluation Criteria:

1. Are the industrial, radiological, and chemical hazards identified for the public, workers, and the environment?
2. Are hazards defined sufficient to grade and identify required Project emphasis areas?
3. Is the hazards analysis kept current?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.1.2		**Program hazards shall be identified and documented.**		
1.3.2	1.1.2.1		An analysis of optional methods to meet this requirement is not applicable	PE PS	E
1.5.1, 1.5.2	1.1.2.2		Define the baseline configuration.	PE PI	P
1.3.2, 1.5.5	1.1.2.2.1	3	Identify the industrial, chemical, and radiological hazards within the program configuration (see requirement 1.1.1). [1.1.2.a]	PS	E
1.3.2, 1.5.5	1.1.2.2.2	3	Perform process hazards analysis (see requirement 1.1.1). [1.1.2.a]	PS	E
1.3.2, 1.5.5	1.1.2.2.3	3	Grade hazards to identify program emphasis areas for detailed analysis and development of controls. [1.1.2.a]	PS	E
1.3.2, 1.5.5	1.1.2.2.3.1	3	Record the hazard analyses in the safety envelope documentation. [1.1.2.a]	PS	E
1.5.1, 1.5.2	1.1.2.2.4	3	Determine required baseline maintenance including methods for keeping the hazards analysis current. [1.1.2.b]	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.2.2.4.1	3	Determine the periodicity of hazards re-assessment of program operations/conditions. [1.1.2.b]	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.1.2.2.4.2	3	Identify controls for triggering hazards assessment for new/modified operations. [1.1.2.b]	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.3	1.1.2.2.5	3	Determine method to verify baseline meets requirement.	PI	P
1.4.1, 1.4.2	1.1.2.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.5	1.1.2.3.1	1	Obtain authorization of the safety basis (SAR). [1.1.2.a]	PE	P
1.5.1, 1.5.2	1.1.2.3.2	1	Periodically re-assess hazards. [1.1.2.b]	PE PS	P
1.5.4	1.1.2.3.2.1	1	Assess hazards for new/modified operations. [1.1.2.b]	PE PS	P
1.5.5	1.1.2.3.2.2	1	Obtain approval of changes in the safety basis.	PE	P
1.5.1, 1.5.2	1.1.2.4		Verify compliance with this requirement	PE	P
1.4.1, 1.4.2	1.1.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS

Requirement Category: 1.1 Define the Safety Envelope

Requirement: 1.1.3 The Project risk(s) and required controls shall be documented. DOE 5480.7A, DOE 5480.21, DOE 5480.22, DOE 5480.23, ANSI 8.1, 8.3, 8.7, 8.20, DOE 5480.31, DOE 6430.1A; 10 CFR 835, 29 CFR 1910, 29 CFR 1926; (F:All)

Evaluation Criteria:

1. Are identified risks commensurate with those identified in a comparable private industrial operation?
2. Are Project risk commensurate with other risks assumed by LMES and DOE?
3. Are required controls feasible?
4. Are risks sufficiently defined to identify where controls are needed and to what degree?
5. Is the risk analysis kept current?
6. Is ALARA used in identifying control?
7. Are risk controls identified for applicable operational states (start-up, steady state, off-normal, emergency, and standby)?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.1.3		**The program risk(s) and required controls shall be documented.**		
1.4.1, 1.4.2	1.1.3.1	1	An analysis of optional methods includes the analysis of eliminating the risk(s) or controlling the risk(s).	PS	P
1.5.1, 1.5.2	1.1.3.2		Define baseline configuration	PE PI	P
1.5.5	1.1.3.2.1	3	Identify program risks relative to the configuration defined in requirement 1.1.1. Use identified standards for determining the relevance of program risks to other DOE and industry risks. [1.1.3.b]	PE PS	P
1.3.2, 1.5.1, 1.5.2, 1.5.5	1.1.3.2.1.1	3	Identify plausible accident scenarios given identified functional hazards. Plausible accident scenarios to be identified will include scenarios stemming from cylinder breaches (continued below)	PE PS	E
1.3.2, 1.5.1, 1.5.2, 1.5.5	1.1.3.2.1.1 (continued)	3	into the ullage space and degraded cylinder conditions as possible initiators. [1.1.3.b]	PE PS	E
1.3.2, 1.5.5	1.1.3.2.1.2	3	Determine the probability of accidents scenarios occurring. [1.1.3.b]	PS	E
1.3.2, 1.5.1, 1.5.2, 1.5.5	1.1.3.2.2	1	Determine controls necessary to decrease the probability of occurrence for accidents with unacceptable consequences to a tolerable level (ALARA). Controls are determined for anticipated operational states. [1.1.3.a, 1.1.3.b, 1.1.3.f]	PE PS	E
1.3.2, 1.5.5	1.1.3.2.3	3	Complete the risk analysis and risk control sections of the SAR relative to the program. [1.1.3.b]	PE PS	E
1.4.1, 1.4.2, 1.5.5	1.1.3.2.3.1	3	Document the risk management matrix.	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.4	1.1.3.2.4	3	Determine required baseline maintenance.	PE	P
1.4.1, 1.4.2	1.1.3.2.4.1	2	Identify intent and periodicity of risk re-assessments. [1.1.3.c, 1.1.3.d]	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.5	1.1.3.2.4.2	3	Identify controls for triggering risk assessments for new/modified operations. [1.1.3.c, 1.1.3.d, 1.1.3.e]	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.5	1.1.3.2.5	3	Determine method to verify baseline meets requirement.	PI	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.1.3		**The program risk(s) and required controls shall be documented. (continued)**		
1.4.1, 1.4.2	1.1.3.3		Implement baseline configuration. (see 1.1.1 configuration management)	PE	P
1.4.1, 1.4.2, 1.5.5	1.1.3.3.1	1	Obtain authorization of safety basis (Safety Analysis Report). [1.1.3.b]	PE	P
1.5.1, 1.5.2	1.1.3.3.2	1	Periodically re-assess risk within the program. [1.1.3.c, 1.1.3.d]	PE PS	P
1.5.1, 1.5.2	1.1.3.3.3	3	Assess risks of new/modified operations. [1.1.3.c, 1.1.3.d, 1.1.3.e]	PE PS	P
1.5.1, 1.5.2	1.1.3.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	1.1.3.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS

Requirement Category: 1.2 Operate Within the Safety Envelope

Requirement: 1.2.1 Required risk controls shall be implemented. DOE 5480.23, ANSI 8.1, 8.3, 8.7, 8.20, DOE 5633.3B; 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:

1. In practice, do the risk controls actually decrease to a tolerable level the probability of an accident with unacceptable consequences occurring?
2. Are measures and controls in place to eliminate or mitigate identified risks?
3. Are risk controls integrated within the Project and with site requirements?
4. Are affected personnel knowledgeable about risk controls?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.2.1		**Required risk controls shall be implemented**		
1.5.1, 1.5.2, 1.5.5	1.2.1.1	1	An analysis of optional methods includes the analysis of engineered controls, administrative controls, and/or multiple controls for making risk(s) acceptable.	PS	P
1.5.1, 1.5.2	1.2.1.2		Define baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1	3	Develop all program risk controls in accordance with the system configuration (see requirement 1.1.1). Integrate the development of risk controls with site requirements.	PE PS	P
1.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.1	1	Verify the industrial hazard controls to be administered by the industrial hygiene program. [1.2.1.a]	PE	P
1.1.1, 1.1.3, 1.1.5, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.2	1	Verify the inventory controls including movement and processing authorization to be administered by the NMC&A program. [1.2.1.b]	PE	P
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.3	1	Verify criticality controls including mitigative alarms and inventory segregation to be administered by the Nuclear Criticality Safety program. [1.2.1.c]	PE	P
1.1.2, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.4	1	Verify the safeguards and security controls including periodic patrols, physical boundaries, and facility lighting to be administered by the Safeguards and Security program.	PE	P
1.1.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.5	1	Verify operational controls to prevent cylinder placement in ground contact beyond a specified duration. Specify duration. [1.2.1.e]	PE	P
1.1.4, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.1.6	1	Verify in the authorization of cylinder repair/replacement through contracted services the validation of a safety envelope for specified operations. [1.2.1.f]	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.3	1.2.1.2.1.7	1	Verify integration of program hazards with site emergency preparedness.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.2	1	Develop implementation means for all program risk controls.	PS	P
1.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.2.1	1	Develop a training program for personnel on program risks and subsequent controls.	PS	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.2.1		**Required risk controls shall be implemented. (continued)**		
1.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.3	1	Determine required maintenance of risk controls.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.4	1	Determine method to verify baseline meets requirement.	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.2.4.1	1	Determine the effectiveness of controls for reducing, eliminating, and mitigating risks.	PE PS	P
1.4.1, 1.4.2	1.2.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.3.1	1	Identify current risks that are above acceptable program risks.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.3.2	3	Develop risk reduction actions.	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.1.3.3	3	Prioritize and implement risk reduction actions utilizing a risk reduction matrix for guidance. [1.2.1.g]	PE PS	P
1.1	1.2.1.3.4	1	Implement controls. [1.2.1.a, 1.2.1.b, 1.2.1.c, 1.2.1.d, 1.2.1.e, 1.2.1.f]	PE	P
1.1	1.2.1.3.5	1	Train personnel.	PE PS	P
1.1	1.2.1.3.6	1	Implement risk control maintenance.	PE	P
1.5.1, 1.5.2	1.2.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	1.2.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO1: ACHIEVE AND MAINTAIN ACCEPTABLE RISKS

Requirement Category: 1.2 Operate Within the Safety Envelope

Requirement: 1.2.2 Performance shall be monitored and evaluated to identify potential risks within the Project. DOE 4700.1; 10 CFR 830.120, 10 CFR 835; USEC-651; (F:All)

Evaluation Criteria:

1. Is technical and operational performance monitored for risks?
2. Are lessons learned outside the Project being monitored and evaluated for improvements in the Project?
3. Are occurrences investigated and subsequent recommendations implemented?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	1.2.2		**Performance shall be monitored and evaluated to identify potential risks within the program**		
1.3.2	1.2.2.1		An analysis of optional methods is not applicable.	PE PS	E
1.5.1, 1.5.2	1.2.2.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.2.2.1	2	Identify risk monitoring and evaluation tools to be used in the program. These tools will include technical and operational performance monitoring, company, corporate and industry lessons learned sharing, and investigations of occurrences. [1.2.2.b]	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	1.2.2.2.1.1	2	Establish a facility safety walk-through program with the intent of identifying risk initiators. [1.2.2.a]	PE PS	P
1.3.2, 1.4.2	1.2.2.2.1.2	1	Model corrosion to project cylinder integrity.	PS	E
1.3.2, 1.4.2	1.2.2.2.2	1	Define standards for when and how these risk monitoring and evaluation tools will be used.	PI PS	E
1.4.1, 1.4.2	1.2.2.2.3	3	Develop a risk monitoring subsystem as necessary to maintain compliance with requirements in Action 2.2 above.	PS	P
1.3.2, 1.5	1.2.2.2.4	1	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	1.2.2.3		Implement baseline configuration.	PE	P
1.5.1, 1.5.2	1.2.2.3.1	1	Train personnel.	PS	P
1.4.1, 1.4.2	1.2.2.3.2	1	Implement the risk monitoring subsystem.	PI PS	P
1.5.1, 1.5.2	1.2.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	1.2.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.1 Mitigate Deterioration of Cylinders

Requirement: 2.1.1 A barrier between the cylinder mild steel containment surfaces and wetness shall be maintained. DOE 6430.1A; 10 CFR 830 120, 10 CFR 835; (F:S&M)

Evaluation Criteria:

1. Is the option selected responsive to current deterioration rates?
2. Does the option integrate with the existing Project?
3. Can the option feasiblely meet the requirement?
4. Are toughness, durability, repairability, and life expectancy criteria established for selecting coatings?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.1		**A barrier between the cylinder mild steel containment and wetness shall be maintained**		
1.3.2	2.1.1.1		An analysis of optional methods for meeting this requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	2.1.1.2		Define baseline configuration.	PE	P
1.1.4.2, 1.3.2	2.1.1.2.1	2	Define performance objectives for coating (toughness, adhesion, porosity, repairability, life expectancy). [2.1.1.a, 2.1.1.c]	PS	E
1.1.4.2, 1.3.2	2.1.1.2.2	2	Select coating.	PS	E
1.1.4.2, 1.3.1, 1.3.2	2.1.1.2.3	3	Develop coating method including surface preparation, coating application, and curing.	PS	E
1.1.4.2, 1.3.2, 1.4.1, 1.4.2	2.1.1.2.4	3	Establish a coating work plan and schedule that prioritizes cylinders on the basis of condition.	PI	E
1.1.4.2 1.3.2	2.1.1.2.5	1	Test coating method.	PS	E
1.1.4.2	2.1.1.2.6	1	Determine method to verify baseline meets requirement. [2.1.1.c]	PE	P
1.1.2.1, 1.1.4.3, 1.3.2	2.1.1.2.7	1	Determine the coating inspection and maintenance intent, method and frequency.	PS	E
1.4.1, 1.4.2	2.1.1.3		Implement baseline configuration.	PE	P
1.1.4.2	2.1.1.3.1	1	Initiate immediate temporary actions to mitigate the deterioration from worst case corrosion rates (paint skirts). [2.1.1.a]	PE PS	P
1.1.4.2	2.1.1.3.2	2	Coat all cylinders per work plan and schedule. [2.1.1a, 2.1.1.b]	PE PS	P
1.1.1	2.1.1.3.3	2	Adjust physical array of cylinders as necessary to maintain coating.	PE PS	P
1.1.4.3 1.1.2.1	2.1.1.3.4	2	Implement coating inspection and maintenance.	PS	P
1.5.1, 1.5.2	2.1.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.1.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.1 Mitigate Deterioration of Cylinders

Requirement: 2.1.2 Water retention on cylinders caused by cylinder structural features shall be minimized. 10 CFR 835, 10 CFR 830.120; (F:S&M)

Evaluation Criteria:

1. Have all structural features been assessed to determine their capacity to retain water?
2. Have features that retain water been modified to allow drainage?
3. Have performance objectives and time of wetness criteria been defined such that they may be verified through inspection techniques?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.2		**Water retention on the cylinders caused by cylinder structural features shall be minimized.**		
1.1.4.3, 1.3.2	2.1.2.1	1	Analyze options to reduce cylinder time of wetness caused by cylinder structural features.	PS	E
1.5.1, 1.5.2	2.1.2.2		Define the baseline configuration.	PE	P
1.1.4, 1.3.2, 1.5.1, 1.5.2	2.1.2.2.1	2	Define acceptable cylinder time of wetness in a manner such that it is technically meaningful and can be verified.	PS	E
1.1.4, 1.3.2	2.1.2.2.2	3	Identify all cylinder structural features that retain water beyond acceptable time of wetness.	PS	E
1.1.2, 1.1.4, 1.3.2	2.1.2.2.2.1	3	Define performance objectives of the cylinder structural features relative to the surveillance and maintenance function.	PS	E
1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.1.2.2.2.2	3	Integrate the structural feature performance for the surveillance and maintenance function with performance objectives for the other system functions.	PI	E
1.1.4, 1.3.2	2.1.2.2.3	1	Identify and evaluate modifications to cylinder structural features that retain water to allow drainage.	PS	E
1.1.2, 1.1.4, 1.3.2	2.1.2.2.4	1	Develop a structural feature inspection and maintenance plan to maintain compliance with this requirement, and integrate the plan with the program.	PI	E
1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.1.2.2.5	1	Determine cylinder inspection/acceptance requirements for transitioning cylinders from one function to another if one cylinder acceptance criteria is not adopted for all functions.	PE PS	E
1.4.1, 1.4.2	2.1.2.2.6	1	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.1.2.3		Implement baseline configuration.	PE	P
1.1.4.3	2.1.2.3.1	1	Implement immediate actions to reduce cylinder time of wetness (clear debris from skirts). [2.1.2.a]	PE PS	P
1.1.4.3	2.1.2.3.2	2	Modify structural features to meet acceptable cylinder time of wetness. [2.1.2.a]	PE PS	P
1.1.2.1, 1.1.4.3	2.1.2.3.3	1	Perform inspection and maintenance of cylinder structural features. [2.1.2.a]	PS	P
1.1.2, 1.1.4	2.1.2.3.4	1	Implement baseline maintenance.	PE PS	P
1.5.1, 1.5.2	2.1.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.1.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.1 Mitigate Deterioration of Cylinders

Requirement: **2.1.3 Water retention on cylinders caused by cylinder support structures shall be minimized.** 10 CFR 835, 10 CFR 830.120; (F:S&M)

Evaluation Criteria:

1. Have all support structural designs been assessed to determine their capacity to retain water?
2. Have features that retain water been modified to allow drainage?
3. Do cylinder support structure design criteria include the protection of cylinder coating?
4. Does the design of support structures integrate with other system performance objectives?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.3		**Water retention on the cylinders caused by cylinder support structures shall be minimized.**		
1.2.1, 1.2.2, 1.3.2	2.1.3.1	3	Analyze cylinder support structure options to minimize cylinder time of wetness and accomplish other system performance objectives.	PS	E
1.5.1, 1.5.2	2.1.3.2		Define baseline configuration.	PE PI	P
1.1.2, 1.1.4.4, 1.2.1, 1.2.2, 1.3.2	2.1.3.2.1	2	Define performance objectives of cylinder support structures with respect to system functions including the interface with cylinder coatings, periodic inspections, and water drainage. [2.1.3.a, 2.1.3.b]	PS	E
1.1.2.1	2.1.3.2.2	1	Identify cylinder support structures that do not meet performance objectives.	PS	P
1.1.2, 1.1.4.4, 1.2.1, 1.2.2, 1.3.2	2.1.3.2.3	2	Identify and evaluate modifications to cylinder support structures to meet cylinder time of wetness performance objectives.	PS	E
1.1.2, 1.1.4.4, 1.2.1, 1.2.2, 1.3.2	2.1.3.2.3.1	2	Assess current designs to determine their capacity to drain water.	PS	E
1.1.2, 1.1.4, 1.3.2	2.1.3.2.4	2	Determine inspection and maintenance methods to maintain compliance with this requirement.	PE PS	E
1.5.1, 1.5.2	2.1.3.2.5	1	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.1.3.3		Implement baseline configuration.	PE	P
1.1.1.1	2.1.3.3.1	1	Implement immediate actions to meet performance objectives. [2.1.3.a, 2.1.3.b]	PE PS	P
1.2.2	2.1.3.3.2	1	Procure or modify support structures to meet acceptable cylinder time of wetness.	BM PI PS	P
1.1.2.1, 1.1.4.3	2.1.3.3.3	1	Perform inspection and maintenance of cylinder support structures to ensure meeting this requirement.	PE PS	P
1.5.1, 1.5.2	2.1.3.4		Verify compliance with requirement.	PE	P
1.4.1, 1.4.2	2.1.3.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.1 Mitigate Deterioration of Cylinders

Requirement: 2.1.4 Water retention on and adjacent to storage facilities shall be minimized.

DOE 6430.1A; 10 CFR 830.120, 10 CFR 835; (F:S&M)

Evaluation Criteria:

1. Have all storage facilities been assessed to determine their capacity to meet time of wetness performance objectives?
2. Have features that retain water been modified to allow drainage?
3. Is the storage facility designed to minimize water retention?
4. Are the performance objectives for the facility including expected life, factored into design and construction?
5. Is there maintenance on the drainage routes from the facilities to maintain drainage.
6. Have time-of-wetness performance objectives been defined using technical bases?
7. Have the facility performance objectives and inspection procedures been integrated within the cylinder Project?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.4		**Water retention on and adjacent to storage facilities shall be minimized.**		
1.3.2	2.1.4.1		An analysis of optional methods to meet this requirement is not applicable	PE PS	E
1.5.1, 1.5.2	2.1.4.2		Define the baseline configuration.	PE PI	P
1.1.4, 1.1.5, 1.3.2	2.1.4.2.1	3	Define, using technical basis, storage facility performance objectives including retention of moisture, operational use, and expected life. [2.1.4.a, 2.1.4.b]	PS	E
1.1.2, 1.1.4	2.1.4.2.2	2	Identify storage facility features that retain water beyond acceptable time of wetness performance objectives.	PE PS	P
1.1.4, 1.2.2, 1.3.2	2.1.4.2.3	2	Identify and evaluate modifications to existing storage facilities and new storage facility designs so that performance objectives are met.	PS	E
1.1.4.4, 1.2.2, 1.3.2, 1.4.1	2.1.4.2.3.1	2	Assess current storage facilities for deficiencies in meeting performance objectives.	PE PS	E
1.1.4, 1.2.2, 1.5.2	2.1.4.2.3.2	3	Assess current facility design and construction methods to performance objectives.	PE	P
1.1.1, 1.1.2, 1.1.4, 1.3.2	2.1.4.2.4	2	Identify and evaluate modifications to the cylinder storage array to meet system performance objectives.	PS	E
1.1.2, 1.1.4, 1.4.1, 1.4.2	2.1.4.2.4.1	3	Integrate storage array design with system functions including anticipated surveillance and maintenance of cylinders. [2.1.4.c]	PS	P
1.5.1, 1.5.2	2.1.4.2.5	3	Determine inspection and maintenance of storage facilities to maintain compliance with this requirement.	PE	P
1.5.1, 1.5.2	2.1.4.2.6	2	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.1.4.3		Implement baseline configuration.	PE	P
1.1.1.1	2.1.4.3.1	1	Implement immediate actions to reduce cylinder time of wetness (remove from ground contact, improve drainage of existing yards).	PE	P
1.4.1, 1.4.2	2.1.4.3.2	3	Determine demand for modifications and new facilities.	PI	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.4		**Water retention on and adjacent to storage facilities shall be minimized. (continued)**		
1.1.4.5, 1.2.2	2.1.4.3.3	1	Build new or modify storage facilities to meet cylinder performance objectives. Utilize new/modified facilities. [2.1.4.b]	BM PE PS	P
1.1.4	2.1.4.3.4	1	Adjust cylinder storage array. [2.1.4.c]	PE PS	P
1.1.4.4, 1.1.2.1	2.1.4.3.5	1	Perform inspection and maintenance of the storage facilities to ensure that this requirement is met.	PE PS	P
1.5.1, 1.5.2	2.1.4.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.1.4.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.1 Mitigate Deterioration of Cylinders

Requirement: 2.1.5 Cylinder valve and plug integrity shall be maintained to Project standards.

10 CFR 830.120, 10 CFR 835; USEC-651; (F:S&M)

Evaluation Criteria:

1. Are criteria identified to allow existing valves to be operated when necessary?
2. Are failed valves and plugs detected and repaired/replaced?
3. Have cylinder valve and plug performance criteria been defined in accordance with applicable industry standards and codes?
4. Has cylinder valve and plug inspection and maintenance been integrated with other system activities?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.5		**Cylinder valve and plug integrity shall be maintained to program standards.**		
1.3.2	2.1.5.1		An analysis of optional methods for meeting this requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	2.1.5.2		Define the baseline configuration.	PE PI	P
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2, 1.5.1	2.1.5.2.1	2	Identify performance objectives for cylinder valve and plugs for each system function under the anticipated operational states. Define performance in terms of industry standards to the extent possible.	PE PS	E
1.3.2, 1.5.1	2.1.5.2.2	2	Integrate these performance objectives with the required configuration of the valve and plug. (packing, port and packing nut condition, valve body, threads showing, stem seat, torque, thread to boss interface including the presence of tape).	PE PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.1.5.2.3	2	Determine inspection/acceptance requirements for transitioning from one function to another if one valve and plug baseline configuration is not implemented. [2.1.5.a, 2.1.5.b]	PE PS	E
1.1.2, 1.1.4, 1.3.2, 1.5.2	2.1.5.2.4	1	Develop a valve and plug management program to ensure that performance objectives are met. [2.1.5.a]	PE PI PS	E
1.1.2, 1.1.4, 1.3.2	2.1.5.2.4.1	1	Determine the necessary periodic surveillance and preventive maintenance of valves and plugs. [2.1.5.a, 2.1.5.b]	PE PS	E
1.1.2, 1.1.4, 1.3.2, 1.5.2	2.1.5.2.4.2	1	Determine methods and when valves and plugs should be repaired/replaced as corrective maintenance. [2.1.5.b]	PI PS	E
1.1.4.3, 1.3.2	2.1.5.2.4.3	1	Determine methods and frequencies for valve and plug surveillance and preventive maintenance. [2.1.5.a]	PI	E
1.4.1, 1.4.2	2.1.5.2.5	2	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.1.5.3		Implement the baseline configuration.	PE	P
1.1.4.3	2.1.5.3.1	2	Replace or repair of all missing or damaged cylinder valve or plug protective measures. (This is restricted to only those measures that were installed or recommended by the cylinder manufacturer.) [2.1.5.c]	PE PS	P
1.1.4.3	2.1.5.3.2	1	Implement the valve and plug management program. [2.1.5.a]	PE PS	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.1.5		**Cylinder valve and plug integrity shall be maintained to program standards. (continued)**		
1.1.2.1	2.1.5.3.3	1	Periodically inspect the cylinders to detect failed valves and plugs. [2.1.5.b]	PE PS	P
1.1.4.3	2.1.5.3.4	1	Repair/replace failed valves and plugs so that the performance criteria are met. [2.1.5.b]	PE PS	P
1.5.1, 1.5.2	2.1.5.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.1.5.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY
Requirement Category: 2.2 Mitigate Damage to Cylinders
Requirement: 2.2.1 Cylinder containment integrity shall be maintained during handling, processing, and transport operations. DOE 5480.19, DOE 5633.3B, DOE 6430.1A; 10 CFR 830.120, 10 CFR 835, 29 CFR 1910, 49 CFR; USEC-651; (F:H&S, CT, OT)

Evaluation Criteria:

1. Does the baseline address the concern of handling, processing, and transporting corroded cylinders?
2. Do the handling, processing, and transporting operations damage the protective coating? If so, is there a program to mitigate such damage?
3. Have engineered controls been designed and implemented to prevent cylinder damage during handling, processing, and transporting operations?
4. Are redundant controls and constraints in place to identify, handle, process, and transport corroded cylinders?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.2.1		**Cylinder containment integrity shall be maintained during handling, processing, and transport operations.**		
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.2.1, 1.3.2	2.2.1.1	2	Analyze options that would prevent cylinder damage (including new or modified equipment) during handling, processing, and transporting operations.	PS	E
1.5.1, 1.5.2	2.2.1.2		Define the baseline configuration.	PE PI	P
1.1.4.4, 1.2.1, 1.3.2	2.2.1.2.1	1	Identify equipment performance objectives relative to handling, processing, and transport operations. [2.2.1.e]	PE	E
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.3.2, 1.5.2	2.2.1.2.2	3	Identify methods and equipment to be used to handle, process, and transport cylinders and their contents.	PE	E
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.2.1, 1.3.2	2.2.1.2.3	2	Identify performance objectives for cylinders, support structures, and storage facilities relative to handling, processing, and transporting methods and equipment. [2.2.1.f]	PE	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.2.1.2.3.1	1	Define acceptable cylinder integrity, incorporating cylinder degradation concerns, for handling, processing, and transport.	PS	E
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.2.1.2.4	2	Identify engineered control(s) for each function that are needed to prevent, reduce, and mitigate cylinder and coating damage.	PS	E
1.1.4.2, 1.2.1, 1.2.2, 1.3.2	2.2.1.2.4.1	3	Integrate the protection of cylinder coatings into the saddle design. [2.2.1.f]	PS	E
1.2.1, 1.2.2, 1.3.2	2.2.1.2.4.2	2	Incorporate into new handling equipment design additional engineered controls to prevent coating damage from the equipment and damage when placing cylinder on support structures. [2.2.1.d]	PS	E
1.1.1, 1.3.2	2.2.1.2.4.3	2	Evaluate engineered controls to mitigate damage to cylinders and coatings from the use of existing equipment. [2.2.1.e]	PS	E

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.2.1		**Cylinder containment integrity shall be maintained during handling, processing, and transport operations. (continued)**		
1.3.2, 1.5.5	2.2.1.2.5	1	Identify operational control(s) for each function that are needed to prevent, reduce, and mitigate cylinder damage during test/demonstration, start-up, routine, emergency, off-normal, and standby states of operation.	PS	E
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.3.2	2.2.1.2.5.1	2	Define methods for handling, processing and transporting cylinders and corroded cylinders to meet system performance objectives. [2.2.1.a, 2.2.1.g]	PE PS	E
1.5.1, 1.5.2	2.2.1.2.5.2	3	Establish movement and processing authorization requirements. [2.2.1.h]	PI PS	P
1.5.1, 1.5.2	2.2.1.2.5.3	3	Determine handling route specifications. [2.2.1.c]	PE PS	P
1.5.1, 1.5.2	2.2.1.2.5.4	2	Develop operational procedures for handling, processing, and transporting cylinders. Integrate hoisting and rigging handbook guidelines into cylinder movement procedures. [2.2.1.a]	PI	P
1.5.1, 1.5.2	2.2.1.2.5.5	3	Integrate degraded cylinder conditions into operational procedures. Utilize hoisting and rigging handbook guidelines where applicable. [2.2.1.g]	PI	P
1.5.1, 1.5.2	2.2.1.2.6	2	Identify necessary inspection and maintenance of equipment and operations to ensure compliance with this requirement and ensure non-conforming and non-compliant cylinders are managed safely. [2.2.1.b]	PE PI PS	P
1.5.1, 1.5.2	2.2.1.2.7	3	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.2.1.3		Implement baseline configuration.	PE	P
1.1.4.4, 1.2.1	2.2.1.3.1	3	Modify existing equipment to add additional engineered controls. [2.2.1.d]	PE PS	P
1.1.1, 1.4.1, 1.4.2	2.2.1.3.2	1	Implement a safe move program. [2.2.1.c, 2.2.1.g]	PE PS	P
1.1.1, 1.4.1, 1.4.2	2.2.1.3.2.1	1	Implement administrative controls. [2.2.1.c]	PE PI	P
1.1.1.1, 1.1.2.1, 1.1.3, 1.1.4.1, 1.1.4.2, 1.1.4.3, 1.1.4.4, 1.1.5	2.2.1.3.3	1	Perform the necessary inspection and maintenance on equipment and operations including the verification actions to compensate for non-conforming and potentially non-compliant cylinders. [2.2.1.b]	PE PS	P
1.1.4.3 1.1.4.4	2.2.1.3.4	1	Implement baseline maintenance.	PE	P
1.5.1, 1.5.2	2.2.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.2.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.2 Mitigate Damage to Cylinders

Requirement: 2.2.2 Cylinder handling, processing, and transporting equipment operators shall be proficient. 10 CFR 830.120; (F:H&S, CT, OT)

Evaluation Criteria:

1. Are operator skill and training objectives and qualifications specified?
2. Do operators demonstrate skills necessary to perform their functions without damaging the cylinders, support structures, equipment, or storage facilities?
3. Is documentation of operator proficiency available?
4. Are knowledge and skill requirements systematically determined?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.2.2		**Cylinder handling, processing, and transporting equipment operators shall be proficient.**		
1.3.2	2.2.2.1		Analysis of optional methods for meeting this requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	2.2.2.2		Define the baseline configuration.	PE PI	P
1.5.1, 1.5.2	2.2.2.2.1	3	Identify all handling, processing, and transporting equipment and the tasks to be performed.	PE PS	P
1.5.1, 1.5.2	2.2.2.2.2	3	Perform a job task analysis for each operation.	PS	P
1.5.1, 1.5.2	2.2.2.2.2.1	3	Define the training objectives and their relationship to operational procedures.	PE PS	P
1.5.1, 1.5.2	2.2.2.2.3	3	Identify potential consequences associated with each operation.	PS	P
1.5.1, 1.5.2	2.2.2.2.3.1	3	Define the necessary operator proficiency in terms of identified standards.	PE PS	P
1.5.1, 1.5.2	2.2.2.2.4	3	Establish training program for cylinder handling, processing, and transporting equipment operators and support crews.	PE PS	P
1.5.1, 1.5.2	2.2.2.2.4.1	3	Develop the training material.	PS	P
1.5.1, 1.5.2	2.2.2.2.4.2	3	Develop procedures to maintain training and qualification documentation.	PI PS	P
1.5.1, 1.5.2	2.2.2.2.5	4	Determine operator and support crew evaluation and retraining methods and frequencies.	PE PS	P
1.5.1, 1.5.2	2.2.2.2.6	3	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.2.2.3		Implement baseline configuration.	PE	P
1.5.1, 1.5.2	2.2.2.3.1	1	Train the operators to the skill level as determined by the task to be performed.	PS	P
1.5.1, 1.5.2	2.2.2.3.1.1	1	Evaluate student performance against objectives and recognized performance standards.	PS	P
1.5.1, 1.5.2	2.2.2.3.2	2	Perform evaluation and requalification according to the training program. [2.2.2.a]	PE PS	P
1.5.1, 1.5.2	2.2.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.2.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.3 Manage Non-Compliant Cylinders

Requirement: 2.3.1 Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated service life and configuration. DOE 6430.1A; ANSI N14.1; USEC-651; (F:S&M, CT)

Evaluation Criteria:

1. Are replacement parts designed to industry standards and within the Project safety envelope?
2. Does the procurement process utilize qualified vendors?
3. Do replacement parts specifications include service life and configuration?
4. Do the manufactured products meet the design criteria?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.3.1		**Replacement cylinders, valves, and plugs shall be designed, manufactured, and procured in accordance with anticipated live and configuration.**		
1.3.2	2.3.1.1		An analysis of optional methods to meet this requirement is not applicable	PE PS	E
1.5.1, 1.5.2	2.3.1.2		Define the baseline configuration.	PE PI	P
1.1.4.1, 1.1.4.3	2.3.1.2.1	2	Determine service life and other performance objectives of replacement parts.	PS	P
1.1.4.3	2.3.1.2.2	2	Identify required spare parts inventory and procurement capacity and duration.	BM PS	P
1.5.1	2.3.1.2.3	2	Document design specifications for replacement parts that include materials, tolerances, and manufacturing procedures that are acceptable in meeting the expected service life, reliability, and performance objectives. (continued below)	PS	P
1.5.1	2.3.1.2.3 (continued)	2	Incorporate industry standards into design specifications.	PS	P
1.4.1, 1.4.2	2.3.1.2.4	3	Establish a procurement quality control program to ensure specifications are met.	PE PI	P
1.4.1, 1.4.2	2.3.1.2.5	2	Identify qualified vendors.	BM PS	P
1.5.1, 1.5.2	2.3.1.2.6	2	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.3.1.3		Implement baseline configuration.	PE	P
1.1.4.3	2.3.1.3.1	2	Obtain a spare parts inventory in accordance with projected demand.	PE PS	P
1.5.1, 1.5.2	2.3.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.3.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.3 Manage Non-Compliant Cylinders

Requirement: 2.3.2 Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions. DOE 5480.23; 10 CFR 830.120; (F:S&M, CT)

Evaluation Criteria:

1. Are hazards associated with processing degraded cylinders identified?
2. Are these identified hazards included in personnel training and other command media (such as contracts with outside organizations)?
3. Have minimum experience and training requirements been established for working and performing emergency response in a potential UF_6 hazard?
4. Does a mechanism exist to update training and command media as additional cylinder characterization data is processed?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.3.2		**Personnel replacing/repairing cylinders shall be knowledgeable of deteriorated cylinder conditions.**		
1.1.1, 1.1.4, 1.3.2	2.3.2.1	3	Analyze option to automate operations involving deteriorated cylinders.	PS	E
1.5.1, 1.5.2	2.3.2.2		Define baseline configuration.	PE PI	P
1.5.1, 1.5.2	2.3.2.2.1	4	Identify and document hazards of cylinders for identified conditions and the level of skill and knowledge necessary to perform tasks on or around those cylinders.	PS	P
1.5.1, 1.5.2	2.3.2.2.2	4	Include cylinder conditions, associated hazards, and required experience and training as a part of project command media, including: training, procedures, contracts, etc.	PI	P
1.5.1, 1.5.2	2.3.2.2.3	2	Integrate training and command media revisions with cylinder condition data processing. [2.3.2.a]	PS	P
1.5.1, 1.5.2	2.3.2.2.4	4	Determine required retraining frequency. [2.3.2.a]	PE PS	P
1.5.1, 1.5.2	2.3.2.2.5	1	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.3.2.3		Implement baseline configuration.	PE	P
1.5.1, 1.5.5	2.3.2.3.1	1	Periodically update documents reporting cylinder conditions and associated hazards.	PS	P
1.5.1, 1.5.2	2.3.2.3.2	1	Notify performing personnel of degraded cylinder hazards through training, procedures, contracts, and other command media. [2.3.2.a]	PE PI PS	P
1.5.1, 1.5.2	2.3.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.3.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO2: ACHIEVE AND MAINTAIN CYLINDER INTEGRITY

Requirement Category: 2.3 Manage Non-Compliant Cylinders

Requirement: 2.3.3 Non-compliant cylinders shall be repaired or replaced to meet Project standards. DOE 5480.23; 10 CFR 830-120, 10 CFR 835; (F:S&M, CT)

Evaluation Criteria:

1. Is repair to cylinders conducted in accordance with maintaining cylinders as coded vessels?
2. Are cylinder Project standards commensurate with recognized industrial standards?
3. Do the permanent repairs bring the cylinder into conformance with cylinder performance objectives?
4. Is the disposition of non-compliant cylinders a risk-based decision?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	2.3.3		**Non-compliant cylinders shall be repaired or replaced to meet program standards.**		
1.1.4, 1.3.2	2.3.3.1	2	Analyze alternatives to repairing/replacing breached, thinned, and other expected non-conforming cylinder conditions?	PS	E
1.5.1, 1.5.2	2.3.3.2		Define baseline configuratin.	PE PI	P
1.5.1, 1.5.2	2.3.3.2.1	1	Document program cylinder standards.	PI PS	P
1.5.1, 1.5.2	2.3.3.2.2	1	Develop immediate response methods for expected non-compliant cylinders.	PI PS	P
1.5.1, 1.5.2	2.3.3.2.3	1	Develop repair/replacement and disposition methods and procedures that are commensurate with cylinder program risks, standards, and where applicable industry standards. [2.3.3.b]	PI PS	P
1.1.2.1	2.3.3.2.4	2	Identify non-compliant cylinders.	PE PS	P
1.4.1, 1.4.2	2.3.3.2.5	2	Prioritize and schedule cylinders in need of repair/replacement according to risk.	PI	P
1.1.4, 1.4.1, 1.4.2	2.3.3.2.6	2	Develop repair/replacement capabilities and capacities with projected demand. [2.3.3.a]	PS	P
1.4.1, 1.4.2	2.3.3.2.7	2	Determine method to verify baseline meets requirement.	PE	P
1.4.1, 1.4.2	2.3.3.3		Implement baseline configuration.	PE	P
1.1.4	2.3.3.3.1	1	Perform immediate actions on cylinders when found to be non-compliant.	PS	P
1.1.4.1	2.3.3.3.2	1	Repair or replace cylinders based on risk-determined, prioritized schedule.	PS	P
1.1.4	2.3.3.3.3	1	Implement baseline maintenance.	PE PS	P
1.5.1, 1.5.2	2.3.3.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	2.3.3.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO3: IMPROVE CONDUCT OF OPERATIONS

Requirement Category: 3.1 Improve Process Controls

Requirement: 3.1.1 The system configuration (physical components, functions, and documents) shall be controlled through a formal process. 10 CFR 830.120; (F:All)

Evaluation Criteria:

1. Are design basis documents integrated with safety analysis?
2. Are changes to system components and process control documents controlled?
3. Are the necessary disciplines involved with reviewing and approving configuration changes?
4. Does a records management system exist?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.1.1		**The system configuration (physical components, functions, and documents) shall be controlled through a formal process.**		
1.5.1, 1.5.2	3.1.1.1	3	Analyze the options for what level(s) of program management should control the system configuration.	PE	P
1.5.1, 1.5.2	3.1.1.2		Define baseline configuration. Note: The physical and finctional baselines defined under Requirement 1.1.1.	PE PI	P
1.5.1, 1.5.2	3.1.1.2.1	1	Develop a configuration change process that includes a review by qualified individuals of changes against the design basis and performance requirement documents. (continued below)	PE PS	P
1.5.1, 1.5.2	3.1.1.2.1 (continued)	1	The change process is to include defined levels of authority and corresponding change categories. [3.1.1.a]	PE PS	P
1.5.1, 1.5.2	3.1.1.2.2	3	Develop a document control and records management process. [3.1.1.a]	PI PS	P
1.5.1, 1.5.2	3.1.1.2.3	3	Develop the intent and periodicity of configuration assessment process and documentation audits.	PS	P
1.4.1, 1.4.2	3.1.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.1.1.3.1	1	Implement the configuration change process. [3.1.1.a]	PE	P
1.5.1, 1.5.2	3.1.1.3.1.1	3	Identify configuration items for configuration control.	PS	P
1.5.1, 1.5.2	3.1.1.3.2	1	Review temporary modifications to facilities and equipment for potential unreviewed safety questions.	PE PS	P
1.5.1, 1.5.2	3.1.1.3.3	1	Review procedures and training to ensure that changes in operational activities do not create an unreviewed safety question.	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.1.1.3.4	1	Implement the document control and records management system.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.1.1.3.5	1	Conduct audits and independent assessments of configuration control, document control, and records management process.	PE PS	P
1.5.1, 1.5.2	3.1.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	3.1.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO3: IMPROVE CONDUCT OF OPERATIONS
Requirement Category: 3.1 Improve Process Controls
Requirement: 3.1.2 Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process. DOE 5480.23, DOE 5633.3B; 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:

1. Do the work controls provide the specifications for what resources are to be used, how the work is to be conducted, and the work performance?
2. Does the work authorization process clearly define the work to be performed, the priority for performing work, and the personnel responsible for performing work?
3. Do work control documents include standards for acceptable results?
4. Is work performed by qualified workers and in accordance with work controls?
5. Do procedures identify precautions and warnings to user?
6. Do procedures accomplish the performance requirements of the task?
7. Are work controls managed at an appropriate level?
8. Are only current documents used to control work?
9. Do work controls account for all operational states (start-up, including demonstration and validation, off-normal, emergency, and standby)?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.1.2		**Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process**		
1.4.1, 1.4.2	3.1.2.1	3	Analyze the options for what level(s) of management should control and authorize work controls.	PE PI PS	P
1.5.1, 1.5.2	3.1.2.2		Define the baseline configuration. The physical, functional, and document baselines are defined under Requirement 1.1.1 actions.	PE PI	P
1.5.1, 1.5.2	3.1.2.2.1	3	Identify the work controls to be used by the system and their intent including the specification of resources, responsibilities, work methods, work performance, and verification.	PI	P
1.5.1, 1.5.2	3.1.2.2.2	1	Develop a process(es) for authorizing and implementing work controls including responsible personnel and positions. This process includes the work control structure.	PI	P
1.5.1, 1.5.2	3.1.2.2.2.1	1	Develop a work control process description and implementing procedures including the integration of safety documentation, emergency response, lessons learned, and site specific requirements. [3.1.2.a, 3.1.2.c]	PI	P
1.5.1, 1.5.2	3.1.2.2.2.2	4	Develop a database to track work controls currently authorized.	PS	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.1.2		**Work controls, activities, procedures, work plans, and permits shall be developed, authorized, and implemented through a structured process. (continued)**		
1.5.1, 1.5.2	3.1.2.2.2.3	1	Incorporate verification and validation steps in the authorization of work controls to ensure the control will accomplish the intent of the task(s).	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.1.2.2.3	3	Develop the intent and periodicity of reviews and audits of the work controls and work control authorization and implementation process(es). Intent is to include 3-site consistency and uniform risk management with the system. [3.1.2.b]	PE	P
1.4.1, 1.4.2	3.1.2.3		Implement baseline configuration.	PE	P
1.5.1, 1.5.2	3.1.2.3.1	1	Train personnel on process controls.	PS	P
1.1, 1.2, 1.3, 1.4.1, 1.4.2	3.1.2.3.2	1	Implement work control process(es). [3.1.2.a]	PE PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.1.2.3.3	1	Manage system documents and records per the document control and records management process.	PE PS	P
1.5.1, 1.5.2	3.1.2.3.4	1	Review and audit work controls and authorization and implementation process(es). [3.1.2.b]	PE	P
1.5.1, 1.5.2	3.1.2.4		Verify compliance with this requirement.	PE	P
1.5.1, 1.5.2	3.1.2.4.1	1	Conduct independent performance based assessments. [3.1.2.d]	PS	P
1.4.1, 1.4.2	3.1.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO3: IMPROVE CONDUCT OF OPERATIONS

Requirement Category: 3.2 Improve Staffing and Training

Requirement: 3.2.1 Personnel shall be selected, trained, and developed through a structured process. DOE 5480.23, DOE 5633.3B; 10 CFR 830.120, 10 CFR 835, 29 CFR 1910.120; (F:All)

Evaluation Criteria:

1. Are jobs analyzed to determine the complexity of the task, severity of the consequences if preformed incorrectly, and the human factors involved with accomplishing the intent of the task?
2. Is personnel selection based on required knowledge, skills, experience, and physical ability?
3. Are training, qualification, and certification requirements identified and determined based on the complexity of the task and potential consequences, the frequency with which it is performed, and the desired proficiency of the performing personnel?
4. Are the learning objectives developed from the analysis data?
5. Are the training media developed and delivered based on the learning objectives?
6. Are retraining frequencies determined by the Project line and training organizations, considering the potential consequences of the task, the complexity of the task, and the frequency with which it is performed?
7. Are training records kept current and available to line supervisors to facilitate work authorization?
8. Is performance periodically monitored and assessed to determine that procedures are being followed, training is effective, and the intent of the operation is being fully met?
9. Is training development integrated with procedure development?
10. Are trainers qualifications identified?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.2.1		**Personnel shall be selected, trained, and developed through a structured process.**		
1.5.1, 1.5.2	3.2.1.1	3	Analyze the options for determining the integration of procedures with training and determine criteria for an integrated development based on tasks.	PI PS	P
1.5.1, 1.5.2	3.2.1.2		Define baseline configuration.	PE PI	P
1.5.1, 1.5.2	3.2.1.2.1	4	Develop a personnel selection and training management plan and implementing procedures based on the complexity of tasks, severity of consequences, and human factors. (continued below)	PI PS	P
1.5.1, 1.5.2	3.2.1.2.1 (continued)	4	Training plan is to include qualification specifications of trainers and training of safety documentation. [3.2.1.a, 3.2.1.b]	PI PS	P
1.5.1, 1.5.2	3.2.1.2.2	4	Determine the performance-based training, qualification, and certification specifications for performing personnel. [3.2.1.d]	PE PS	P
1.1, 1.5, 1.4.1, 1.4.2	3.2.1.2.2.1	3	Specify the degree of training (certification, qualification, etc.) for performing personnel (inspectors) who determine cylinder condition. (continued below)	PE PS	P
1.1, 1.5, 1.4.1, 1.4.2	3.2.1.2.2.1 (continued)	3	The quality of which cylinder conditions are determined impacts the functional and inter-functional risks within the system.	PE PS	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.2.1		**Personnel shall be selected, trained, and developed through a structured process. (continued)**		
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.4.1, 1.4.2	3.2.1.2.2.2	3	Specify the degree of training (certification, qualification, etc.) for performing personnel (operators) who perform work (handle, transport, transfer contents, maintenance) on cylinders. (continued below)	PE PS	P
1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.4.1, 1.4.2	3.2.1.2.2.2 (continued)	3	The quality for which this work is performed can directly impact the immediate and long-term functional risks within the system.	PE PS	P
1.5.1, 1.5.2	3.2.1.2.3	4	Develop training documents (modules, etc.) to train performing personnel based on learning objectives. (continued below)	PI PS	P
1.5.1, 1.5.2	3.2.1.2.3 (continued)	4	Modules are to include safety precautions, hazards, emergency response, lessons learned, and site specific requirements. [3.2.1.e]	PI PS	P
1.5.1, 1.5.2	3.2.1.2.4	4	Develop systems to maintain baseline of trained personnel. Systems are to include training records retention and ready access to current training by authorizing and implementing personnel. [3.2.1.c]	PS	P
1.5.1, 1.5.2	3.2.1.2.5	4	Develop the intent and periodicity of audits, assessments, and reviews of the training program.	PE	P
1.5.1, 1.5.2	3.2.1.2.6	4	Develop a training revision process to accommodate changes in tasks, and improvements to training. The process is to include line and training personnel to determine the extent and frequency of retraining.	PI PS	P
1.5.1, 1.5.2	3.2.1.2.6.1	1	Revise job hazard analyses as necessary.	PS	P
1.4.1, 1.4.2	3.2.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2	3.2.1.3.1	1	Select personnel per criteria in the management plan.	PS	P
1.5.1, 1.5.2	3.2.1.3.2	1	Perform required training, qualification, and certification. [3.2.1.a]	PS	P
1.5.1, 1.5.2	3.2.1.3.2.1	1	Train cylinder inspectors.	PS	P
1.5.1, 1.5.2	3.2.1.3.3	3	Develop and maintain a database to include the following: job and task analysis results, learning objectives, linking of test items, task-to-training data, instructor qualifications, (continued below)	PS	P
1.5.1, 1.5.2	3.2.1.3.3 (continued)	3	training material identification data, training delivery data, employee training history, and training intervals. [3.2.1.c]	PS	P
1.5.1, 1.5.2	3.2.1.3.4	1	Perform retraining as required by line management and training personnel. [3.2.1.b]	PS	P
1.5.1, 1.5.2	3.2.1.3.5	1	Conduct periodic reviews of selection and training process effectiveness. [3.2.1.f]	PE PS	P
1.5.1, 1.5.2	3.2.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	3.2.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO3: IMPROVE CONDUCT OF OPERATIONS

Requirement Category: 3.3 Monitor System Performance

Requirement: 3.3.1 System functions shall be monitored to reinforce expectations for work performance and facility condition. 10 CFR 830.120; (F:All)

Evaluation Criteria:

1. Performance objectives are defined for the system functions.
2. An assessment process exists to evaluate system performance against the objectives.
3. A process exists to evaluate assessment results and improve system performance.
4. The line managers use the performance objectives for monitoring and improving work activities.
5. Performance indicators are used to keep Project personnel and customers informed of progress toward meeting the performance objectives and the mission.

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.3.1		**System functions shall be monitored to reinforce expectations for work performance and facility condition.**		
1.3.2	3.3.1.1		An analysis of optional methods to meet this requirement is not applicable	PE PS	E
1.5.1, 1.5.2	3.3.1.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.3.1.2.1	1	Select and develop performance objectives for the system functions; consider customer expectations and long-range plans.	PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.3.1.2.2	4	Develop an assessment process based on guidelines in Order to evaluate system performance against the objectives, to include observation of work in the field, (continued below)	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.3.1.2.2 (continued)	4	review of other audits/assessments, operating experience, document reviews, interviews of key personnel, facility condition inspections. [3.3.1.a]	PE PI	P
1.4.1, 1.4.2	3.3.1.2.3	3	Develop line management process to evaluate assessment results and improve system performance. (continued below)	PE PI PS	P
1.4.1, 1.4.2	3.3.1.2.3 (continued)	3	The process is to include the method for keeping program personnel and customers informed of the status of the system performance to performance objectives and program mission.	PE PI PS	P
1.4.1, 1.4.2	3.3.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2	3.3.1.3.1	1	Implement the structured process to monitor system functions per the performance objectives. This requires active participation in system functions at all levels. [3.3.1.b]	PE PS	P
1.4.1, 1.4.2	3.3.1.3.2	1	Evaluate assessment results to provide the basis for system improvements, to include the following: evaluate results, define issues, develop mitigating actions, (continued below)	PE PS	P
1.4.1, 1.4.2	3.3.1.3.2 (continued)	1	prioritize actions and cost/benefit analysis of highest priority actions, develop and implement action plan.	PE PS	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	3.3.1		**System functions shall be monitored to reinforce expectations for work performance and facility condition. (continued)**		
1.4.1, 1.4.2, 1.5.1, 1.5.2	3.3.1.3.3	1	Train line-management to use the assessment process for monitoring and improving work activities, including observation skills, performance objectives selection and use, evaluation process skills, and action plan development process.	PE PS	P
1.4.1, 1.4.2	3.3.1.3.4	1	Develop and use performance indicators for the system functions to demonstrate that performance objectives and mission are met to identify trends, and to identify areas requiring improvement. [3.3.1.b]	PE PI	P
1.5.1, 1.5.2	3.3.1.4		Verify compliance with this requirement.	PE	P
1.5.1, 1.5.2	3.3.1.4.1	3	Conduct independent assessments of the evaluation process.	PE PS	P
1.4.1, 1.4.2	3.3.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

Requirement Category: 4.1 Monitor Containment Integrity

Requirement: 4.1.1 Exposure to the environment shall be monitored. DOE 5480.23; 10 CFR 835; (F:S&M)

Evaluation Criteria:

1. Have all pathways of exposure to the environment been identified?
2. Is the monitoring balanced with the potential impact on subsequent phases of the Project?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.1.1		**Exposure to the environment shall be monitored**		
1.3.2	4.1.1.1		An analysis of optional methods for meeting this requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	4.1.1.2		Define baseline configuratin.	PE PI	P
1.5.1	4.1.1.2.1	4	Identify potential pathways of exposure to the environment due to failure of containment integrity.	PS	P
1.5.4, 1.5.5	4.1.1.2.2	3	Develop methods for identifying and quantifying releases to the environment and the effects of releases. The extent of these methods for determining releases is to be commensurate with decontamination and decommissioning of the system. [4.1.1.a, 4.1.1.b]	PS	P
1.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2	4.1.1.2.3	4	Determine the required frequency for performing the monitoring methods, and for periodic assessments of methods and data. [4.1.1.b]	PE PS	P
1.1.2, 1.4.1, 1.3.2, 1.4.2	4.1.1.2.4	3	Determine a method to verify that all potential pathways of exposure to the environment are being monitored.	PE PS	E
1.4.1, 1.4.2	4.1.1.3		Implement baseline configuration.	PE	P
1.1.2	4.1.1.3.1	1	Monitor cylinders and the environment for releases to the environment and the effects of such releases. [4.1.1.b]	PS	P
1.1.2.1	4.1.1.3.2	1	Implement actions to maintain compliance with this requirement.	PS	P
1.5.1, 1.5.2	4.1.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	4.1.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

Requirement Category: 4.1 Monitor Containment Integrity

Requirement: 4.1.2 Cylinder condition shall be monitored. DOE 5480.23; 10 CFR 830.120, 10 CFR 835, 49 CFR 173.420; USEC-651 [NBIC, DF&O]; (F:All)

Evaluation Criteria:

1. Are the cylinder acceptance criteria defined?
2. Are cylinder acceptance criteria integrated with industry standards?
3. Is the inspection frequency technically based?
4. Is the integrity monitoring integrated with other risk control programs (Nuclear Material Control and Accountability and Health & Safety)?
5. Are the inspection methods integrated with the cylinder access (storage array) in order to determine cylinder condition?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.1.2		**Cylinder condition shall be monitored.**		
1.4.1, 1.4.2	4.1.2.1	3	Analyze the integration of cylinder storage array with periodic monitoring to determine system configuration options	PI	P
1.5.1, 1.5.2	4.1.2.2		Define the baseline configuration.	PE PI	P
1.1.2, 1.4.1, 1.4.2	4.1.2.2.1	1	Identify all cylinder monitoring performance objectives.	PE PS	P
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.1.1	1	Perform laboratory studies and other analyses to support the definition of cylinder integrity criteria.	PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.1.2	1	Perform structural analysis in support of the developing functional acceptance criteria.	PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.2	1	Define cylinder functional acceptance criteria based upon applicable industrial standards and cylinder performance objectives. [4.1.2.a, 4.1.2.b]	PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.2.1	2	Develop code case(s) to demonstrate compliance with industry standards. [4.1.2.b, 4.1.2.c]	PS	E
1.1, 1.3.2, 1.4.1, 1.4.2	4.1.2.2.3	2	Identify factors that make cylinders non-conforming and identify constraints necessary to maintain compliance with the safety envelope (non-conformance may be based on non-certified volumes, exceedence of fill limits, etc.) [4.1.2.a]	PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.4	2	Establish inspection/evaluation methods for determining the acceptability of cylinders relative functional criteria. [4.1.2.d]	PS	E
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.4.1	2	Determine a technically acceptable risk-based periodicity to perform inspections and evaluations for determining the acceptability of cylinders' relative functional criteria. [4.1.2.e]	PS	E

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.1.2		**Cylinder condition shall be monitored. (continued)**		
1.5.3	4.1.2.2.4.2	2	Specify the extent to which cylinder anomalies identified during inspections will be documented. The extent of documentation includes the precision for which anomalies will be measured and their location defined (continued below)	PE PS	P
1.5.3	4.1.2.2.4.2 (continued)	2	(i.e., a dent on the right side of the cylinder versus a 1/2" deep, 3" circumferential dent located 5" from the valve side of the valve-end stiffener at the 3 o'clock position).	PE PS	P
1.1.2, 1.5.3	4.1.2.2.4.3	2	Develop the visual inspection/quantitative evaluation integration (the use of visual inspections to select cylinders and general surface areas for obtaining quantitative data to verify compliance with functional criteria).	PE PS	P
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.4.4	2	Define ultrasonic thickness techniques and their application i.e., how many points, and extent of area to measure thickness to verify compliance with functional criteria.	PS	E
1.5.3	4.1.2.2.4.5	1	Integrate inspection/evaluation methods and resultant data with risk controls such as inventory accountability, cylinder maintenance, and contamination control.	PS	P
1.1.1, 1.1.2, 1.2.2	4.1.2.2.4.6	2	Integrate the periodic inspection performance objectives with cylinder accessibility. [4.1.2.f]	PI PS	P
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.3.2	4.1.2.2.4.7	2	Perform laboratory studies to support the cylinder functional acceptance criteria and the cylinder monitoring evaluation techniques.	PS	E
1.4.1, 1.4.2	4.1.2.2.5	3	Determine method to verify that the baseline configuration meets the requirement.	PS	P
1.4.1, 1.4.2	4.1.2.3		Implement baseline configuration.	PE	P
1.1.2.1	4.1.2.3.1	1	Identify existing cylinder conditions.	PS	P
1.1.2.1	4.1.2.3.1.1	1	Determine the baseline condition of each cylinder with respect to functional criteria to the extent visual inspections are applicable.	PE PS	P
1.1.2.1	4.1.2.3.1.2	1	Statistically determine the baseline condition of cylinder populations by obtaining quantitative data.	PE	P
1.1.2.1	4.1.2.3.2	1	Identify non-compliant and non-conforming cylinders.	PS	P
1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5	4.1.2.3.3	1	Implement constraints for non-conforming cylinders.	PE PS	P
1.1.2.1	4.1.2.3.4	1	Periodically monitor cylinder conditions. [4.1.2.e]	PS	P
1.5.1, 1.5.2, 1.5.3	4.1.2.3.5	1	Examine justification of inspection frequency and evaluate the need to adjust.	PE PS	P
1.5.1, 1.5.2	4.1.2.3.6	2	Conduct independent assessments of the evaluation of cylinder condition.	PS	P
1.5.1, 1.5.2	4.1.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	4.1.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

Requirement Category: 4.1 Monitor Containment Integrity

Requirement: 4.1.3 Factors that affect cylinder condition shall be monitored. DOE 5480.23, DOE 6430.1A; 10 CFR 830.120; (F:S&M)

Evaluation Criteria:

1. Has a structured approach to the comprehensive identification of degradation factors been used?
2. Is the monitoring method consistent with the applicable degradation factor?
3. Does the monitoring provide timely and reliable data that will be useful in forecasting cylinder conditions?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.1.3		**Factors that affect cylinder conditions shall be monitored**		
1.3.2, 1.4.1, 1.4.2	4.1.3.1	3	Analyze optional storage configuration to reduce or eliminate degradation factors.	PS1	E
1.5.1, 1.5.2	4.1.3.2		Define baseline configuration.	PE PI	P
1.3.2	4.1.3.2.1	1	Identify, and grade for severity, factors that could degrade cylinder integrity [4.1.3.a].	PS	E
1.3.2, 1.5.3	4.1.3.2.2	3	Develop a database for tracking degradation factor monitoring data.	PS	E
1.1.2, 1.5.3	4.1.3.2.3	3	Develop methods to monitor the degradation factors for the collection of timely and reliable data that is useful in forecasting cylinder condition. Monitoring method is based on applicable degradation factor. [4.1.3.b]	PS	P
1.3.2, 1.5.1, 1.5.2, 1.5.3	4.1.3.2.4	3	Develop a monitoring plan, incorporating the methods and frequencies for performing those methods.	PE PI	E
1.4.1, 1.4.2, 1.5.1, 1.5.2	4.1.3.2.5	3	Determine the intent and frequency for audits, assessments, and reviews of degradation factor monitoring.	PE	P
1.4.1, 1.4.2	4.1.3.2.6	3	Determine methods to verify the baseline meets the requirement.	PE	P
1.4.1, 1.4.2	4.1.3.3		Implement baseline configuration.	PE	P
1.1.4.4, 1.1.2.1	4.1.3.3.1	2	Monitor the cylinder degradation factors. [4.1.3.b]	PE PS	P
1.1.2.1	4.1.3.3.2	3	Record the cylinder degradation factor information in the developed database.	PE	P
1.1.4.3	4.1.3.3.3	3	Implement baseline maintenance.	PS	P
1.5.1, 1.5.2	4.1.3.3.3.1	3	Perform self-assessments and other quality control measures to ensure that the degradation factors are being monitored according to the developed plan.	PS	P
1.5.1, 1.5.2	4.1.3.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	4.1.3.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY

Requirement Category: 4.2 Evaluate Containment Integrity

Requirement: 4.2.1 Cylinders shall be categorized to ensure risks are identified. (F:All)

Evaluation Criteria:

1. Are the categories clearly defined such that all cylinders are categorized?
2. Are the categories conclusive to effective decision making?
3. Do the categories provide for assessment of the overall risks within the Project?
4. Are changes in category definitions conveyed to the trend analysis effort?
5. Have approved procedures been developed to guide the categorization process?
6. Is the categorization method consistent across all three sites?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.2.1		**Cylinders shall be categorized to ensure risks are identified.**		
1.3.2	4.2.1.1		An analysis of optional methods to meet this requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	4.2.1.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2	4.2.1.2.1	2	Review the cylinder functional criteria and degradation factors.	PE PS	P
1.3.2, 1.4.1, 1.4.2	4.2.1.2.2	3	Define and describe categories in terms of cylinder functional criteria and/or factors that could adversely impact cylinder integrity.	PS	P
1.5.1, 1.5.2	4.2.1.2.3	3	Develop procedures for grouping cylinders and storage environments in the defined categories.	PI	P
1.4.1, 1.4.2, 1.5.3	4.2.1.2.4	3	Develop a method for tracking cylinders and storage environments according to their categories.	PS	P
1.4.1, 1.4.2	4.2.1.2.5	3	Determine a method to verify the baseline configuration.	PE	P
1.4.1, 1.4.2	4.2.1.3		Implement baseline configuration.	PE	P
1.1.2.1	4.2.1.3.1	3	Categorize the cylinders and storage environments.	PE	P
1.1.2.1	4.2.1.3.2	3	Record the categorization information to allow tracking.	PI	P
1.5.1, 1.5.2	4.2.1.4		Verify compliance with requirement.	PE	P
1.4.1, 1.4.2	4.2.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO4: EVALUATE AND MONITOR CONTAINMENT INTEGRITY
Requirement Category: 4.2 Evaluate Containment Integrity
Requirement: 4.2.2 Cylinder conditions shall be forecast to direct surveillance and maintenance resources. DOE 4700.1; 10 CFR 830.120; (F:S&M)

Evaluation Criteria:

1. Does the forecasting project the non-compliant cylinder population?
2. Have performance indicators been established to forecast cylinder conditions?
3. Are the forecasted elements commensurate with the intended use of the cylinder (handling, processing, transportation, storage, etc.)?
4. Are the forecasting performance objectives integrated with cylinder integrity monitoring methods?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	4.2.2		**Cylinder conditions shall be forecast to direct surveillance and maintenance resources.**		
1.3.2	4.2.2.1		An analysis of optional methods to meet the requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	4.2.2.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2	4.2.2.2.1	1	Review the data collected as a result of monitoring containment integrity.	PE PS	P
1.3.2, 1.4.1, 1.4.2	4.2.2.2.2	3	Identify which cylinder condition elements are to be forecasted. Elements are to be selected based on intended future use of the cylinders. [4.2.2.a]	PE PS	E
1.4.1, 1.4.2	4.2.2.2.2.1	3	Integrate cylinder condition elements to be forecasted with cylinder categorization. [4.2.2.a]	PI	P
1.1.2, 1.3.2, 1.4.1, 1.4.2	4.2.2.2.3	3	Identify which collected data will be used in the forecasting. Integrate forecasting with monitoring efforts. [4.2.2.a]	PI PS	E
1.3.2, 1.4.1, 1.4.2	4.2.2.2.4	3	Define procedures for forecasting cylinder condition. Using these procedures will identify specific cylinders in need of specific surveillance and maintenance.	PI PS	E
1.5.3	4.2.2.2.5	3	Develop a database system to capture the forecasting information. [4.2.2.b]	PS	P
1.3.2, 1.4.1, 1.4.2	4.2.2.2.6	3	Establish a process to periodically review forecasting results with the performance objectives through the use of performance indicators. [4.2.2.b]	PE PI PS	E
1.4.1, 1.4.2	4.2.2.2.7	3	Determine a method to verify the baseline configuration.	PE	P
1.4.1, 1.4.2	4.2.2.3		Implement baseline configuration.	PE	P
1.3.2, 1.4.1, 1.4.2	4.2.2.3.1	1	Forecast cylinder conditions using the parameters identified. [4.2.2.b]	PE PS	E
1.1.3, 1.1.4, 1.1.5, 1.3.2, 1.4.1, 1.4.2	4.2.2.3.1.1	1	Project the number of non-compliant cylinders.	PE PS	E
1.5.3	4.2.2.3.2	3	Record forecasting information in the developed database. [4.2.2.b]	PE	P
1.5.1, 1.5.2	4.2.2.4		Verify compliance with requirement.	PE	P
1.4.1, 1.4.2	4.2.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO5: ADMINISTER THE SYSTEM

Requirement Category: 5.1 Obtain Resources

Requirement: 5.1.1 Financial resources to sustain the system shall be obtained and utilized. (F:All)

Evaluation Criteria:

1. Are financial requirements systematically developed?
2. Have financial requirements been identified?
3. Are financial resources available to accomplish critical tasks?
4. Are financial resources allocated to critical tasks?
5. Are costs controlled to progress?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	5.1.1		**Financial resources to sustain the system shall be obtained and utilized**		
1.3.2	5.1.1.1		An analysis of optional methods to meet the requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	5.1.1.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2	5.1.1.2.1	1	Develop a standard, systematic method for estimating level of effort within the system to support standard cost estimates.	BM	P
1.4.1, 1.4.2	5.1.1.2.2	1	Identify the critical path of system activities (tasks).	PI	P
1.4.1, 1.4.2	5.1.1.2.3	2	Define budgeting cycle activities and schedules.	PI	P
1.4.1, 1.4.2	5.1.1.2.4	1	Develop a funds allocation and accounting system reflective of the WBS.	BM	P
1.4.1, 1.4.2	5.1.1.2.4.1	1	Obtain accurate accounting of costs (funds committed to date) as needed at the single site and 3-site level to effectively control financial resources.	BM PE	P
1.4.1, 1.4.2	5.1.1.2.5	1	Define and develop financial management methods (review periods, reallocation processes, financial configuration control, etc.).	BM	P
1.4.1, 1.4.2	5.1.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2	5.1.1.3.1	1	Define task (WBS) elements with accounts.	BM PI	P
1.4.1, 1.4.2	5.1.1.3.2	1	Define budget requirements with identified activities (tasks).	PI	P
1.4.1, 1.4.2	5.1.1.3.3	1	Obtain budget authorization.	BM PI	P
1.4.1, 1.4.2	5.1.1.3.4	1	Gather accurate costs.	BM PE	P
1.4.1, 1.4.2	5.1.1.3.5	1	Control costs to the progress of activities (tasks).	BM PE	P
1.5.1, 1.5.2	5.1.1.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	5.1.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO5: ADMINISTER THE SYSTEM

Requirement Category: 5.1 Obtain Resources

Requirement: 5.1.2 Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured. (F:All)

Evaluation Criteria:

1. Is the necessary expertise to accomplish activities identified?
2. Is the necessary expertise retained and used to accomplish tasks?
3. Are roles and responsibilities identified for ensuring activities, subsystems, and functions accomplish objectives?
4. Are organizational structures functional?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	5.1.2		**Intellectual resources (operational, technical, financial expertise) to sustain the system shall be secured.**		
1.4.1, 1.4.2	5.1.2.1	2	Analyze optional methods for obtaining intellectual resources (contract, subcontract, direct employment).	PI PS	P
1.5.1, 1.5.2	5.1.2.2		Define the baseline configuration.	PE PI	P
1.4.1, 1.4.2	5.1.2.2.1	2	Define how disciplines necessary to accomplish system activities and objectives are identified, secured, and allocated.	PI	P
1.4.1, 1.4.2	5.1.2.2.2	1	Establish a program organization reflective of the system functions, subsystems, and activities.	PI	P
1.4.1, 1.4.2	5.1.2.2.3	1	Define roles, responsibilities and qualifications reflective of the organizational structure.	PE PI	P
1.4.1, 1.4.2	5.1.2.2.4	4	Define the personnel performance monitoring system.	PS	P
1.4.1, 1.4.2	5.1.2.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2	5.1.2.3.1	1	Obtain and allocate intellectual resources necessary to operate the system and accomplish activities.	PS	P
1.4.1, 1.4.2	5.1.2.3.2	1	Monitor personnel performance.	PE	P
1.5.1, 1.5.2	5.1.2.4		Verify compliance with this requirement.	PE	P
1.4.1, 1.4.2	5.1.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO5: ADMINISTER THE SYSTEM

Requirement Category: 5.2 Integrate the System Operations

Requirement: 5.2.1 System and technical requirements shall be traceable from the Project mission to implementing documentation. (F:All)

Evaluation Criteria:

1. Are requirements identified?
2. Is there a structured approach to identifying, organizing, and maintaining system, subsystem, functional, component, and activity requirements.
3. Are requirements linked to the mission and implementing documents?
4. Are requirements used in determining system activities (tasks)?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	5.2.1		**System and technical requirement shall be traceable from the program mission to implementing documentation.**		
1.3.2	5.2.1.1		An analysis of optional methods to meet the requirement is not applicable.	PE PS	E
1.5.1, 1.5.2	5.2.1.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.2.1	1	Develop the requirement structure and traceability method(s).	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.2.2	1	Develop a method for controlling and maintaining requirements.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.2.3	1	Develop a method for ensuring system tasks are based on requirements.	PE PI	P
1.4.1, 1.4.2	5.2.1.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.3.1	1	Identify requirements.	PE	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.3.2	1	Trace requirements to the mission and implementing documentation.	PI	P
1.5.1, 1.5.2	5.2.1.3.2.1	1	Reconcile requirements against the results of the necessary and sufficient closure process.	PE PI	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.1.3.3	1	Utilize requirements in identifying and developing system activities (tasks).	PI	P
1.5.1, 1.5.2	5.2.1.4		Verify compliance with requirement.	PE	P
1.4.1, 1.4.2	5.2.1.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P

MO5: ADMINISTER THE SYSTEM

Requirement Category: 5.2 Integrate the System Operations

Requirement: 5.2.2 The system configuration shall be optimized in accordance with life-cycle projections. DOE 5480.19; 10 CFR 830.120, 10 CFR 835; (F:All)

Evaluation Criteria:

1. Is there a projected system life-cycle and phase duration?
2. Is the system configuration based on the projected life-cycle and duration?
3. Is the configuration assessed for efficiency, reliability, and maintainability through the projected life-cycle and duration?
4. Is there a mechanism for reoptimizing the configuration with revised life-cycle projections and new technologies?
5. Are subsystem, function, component, and activity interfaces identified and utilized in modifications to the system configuration?

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	5.2.2		**The system configuration shall be optimized in accordance with life-cycle projections.**		
1.3.2, 1.4.1, 1.4.2	5.2.2.1	2	Trade study alternatives/options of life-cycle projections.	PE PS	E
1.5.1, 1.5.2	5.2.2.2		Define baseline configuration.	PE PI	P
1.4.1, 1.4.2	5.2.2.2.1	1	Define the projected life-cycle including phase durations and operating parameters that impact current phase objectives and criteria. [5.2.2.a, 5.2.2.b]	PS	P
1.4.1, 1.4.2, 1.5.1, 1.5.2	5.2.2.2.2	1	Develop the system configuration and change control based on life-cycle and phase duration projections. [5.2.2.a]	PE	P
1.4.1, 1.4.2	5.2.2.2.3	1	Identify the factors for triggering an assessment of the configuration, i.e., revisions to the life-cycle and duration projections, substandard performance, identification of new technologies. (continued below)	PE PS	P
1.4.1, 1.4.2	5.2.2.2.3 (continued)	1	New technologies include methods for reducing cylinder corrosion. [5.2.2.c]	PE PS	P
1.4.1, 1.4.2	5.2.2.2.4	1	Develop methods/sub-systems for identifying when a configuration assessment is necessary. Methods are to include interaction with corrosion experts, literature on state-of-the-art technology, and attending corrosion engineering conferences. [5.2.2.c]	PE	P
1.4.1, 1.4.2	5.2.2.2.5	2	Develop a method for identifying and controlling the interfaces between organizations, functions, subsystems, components and activities.	PE	P
1.4.1, 1.4.2	5.2.2.3		Implement baseline configuration.	PE	P
1.4.1, 1.4.2	5.2.2.3.1	2	Assess the configuration for efficiency, reliability, and maintainability. [5.2.2.a]	PE	P

WBS #	SEMP #	Pri.	Action	Resp. Org.	(E)DP or (P)MP
	5.2.2		**The system configuration shall be optimized in accordance with life-cycle projections. (continued)**		
1.4.1, 1.4.2	5.2.2.3.1.1	**2**	Determine the three-site aspects of the system configuration. Specifically, determine whether the K-25 cylinder inventory should be relocated to PGDP and PORTS or the long-term maintainability functions should be implemented at K-25	PE	P
1.4.1, 1.4.2	5.2.2.3.2	2	Implement methods for identifying when a configuration assessment is necessary.	PE	E
1.4.1, 1.4.2	5.2.2.3.3	2	Identify the interfaces within the system configuration.	PE PI	E
1.4.1, 1.4.2	5.2.2.3.4	1	Control the interfaces within the system.	PE	P
1.5.1, 1.5.2	5.2.2.4		Verify compliance with this requirement.	PE	P
1.5.1, 1.5.2	5.2.2.4.1	1	Enter documentation into the cylinder management document center regarding corrosion mechanisms and technologies assessed.	PE	E
1.4.1, 1.4.2	5.2.2.5		Adjust baseline as necessary to meet the program requirement.	PE PI	P